The Human Body in Medical Art

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Portrait of Volcher Coiter, oil on canvas, attributed to Nicholas Neufchatel, 1575

(Courtesy of the Germanisches National Museum, Nuremberg)

The Écorché Model and Pre-Vesalian Medical Illustration

And if you have love for such things you may be prevented by nausea; [or] . . . you may be prevented by fear of living during the night hours in the company of these quartered and flayed corpses. . . .

Leonardo da Vinci[1]

The écorché, or flayed, figure is most often associated with either the sixteenth-century *Muscle Men* of Andreas Vesalius's *De Humani Corporis Fabrica* or the eighteenth-century statues and statuettes by Jean Antoine Houdon that emphasize anatomic kinesis. Executed in the graphic and plastic arts, these works were created with a single purpose in mind: to teach anatomy. Yet Volcher Coiter's écorché figure type, which was used in Italian anatomy classes before the mid-sixteenth century, originated in neither the hallmark volumes of Vesalius nor the dissection theaters of Renaissance medicine, but in the artist's studio. The écorché represents both the artist's absorption with the antique world and his precocious activity as an anatomist.

The rise of printing and book production in the late fifteenth century enabled greater communication between scholars.[2] This epoch, known as the Pre-Vesalian era, saw the first opportunity for collaboration between artists and physicians in the production of the illustrated anatomy text. Illustration not only vitalized and clarified the text but also provided accurate information in a detailed and refined state previously unavailable to either the physician or layman. During this era, medieval concepts were sloughed off, to be replaced with empirical investigation.

Beginning with the *Fasciculus Medicinae* of Johannes de Ketham in 1491, illustration became a desired and integral part of the medical text; in the sixteenth century the literary works of surgeons Berengario da Carpi and Giovanni Battista Canano confirm the use of the écorché. This article will examine the significance of the écorché study to the development and preparation of medical illustrations during the Pre-Vesalian era; particular attention will be given to Berengario's classic volumes, *Commentaria* (1521) and *Isagogae Breves* (1522 and 1523).

by Roslynne V. Wilson

The Artist and the Physician

In the late medieval period the artist and physician were separated by income and social class, but by the end of the fifteenth century the accomplishments of the artist had been such that he was seen in a class by himself, one equal to that of position and wealth. Even though the artist and the physician had quite different training, they shared the goal of reviving the antique—the physician by preparing "purified" texts of such ancient physicians as Galen, and the artist by vanquishing his rivals from antiquity or nature herself.[3]

It had been thought previously that the natural cause and effect that had brought the artist and physician together in the production of illustrated medical treatises had been their common membership in the guild of the *medici e speziali*.[4] That explanation was based on such significant friendships as that between Chellini and Donatello, as well as Benivieni and Luca della Robbia.[5] It was more likely, however, that such friendships were motivated by the physician's desire to garner fame by means of publication. Evidence of such activity includes the Gregorii brothers' commission to the Bellini shop in Venice for illustrations for the 1493 edition of the *Fasciculo di Medicina* that followed the success of their first publication in this series, Ketham's 1491 *Fasciculus Medicinae*. It is well known that the *Fasciculus* went through fourteen editions, all of which were illustrated. Although the medical man would value the artist's craft and superior knowledge of anatomy, it seems safe to infer that the prime catalyst for the collaboration of artist and physician was the entrepreneurial concern of the editor or publisher to have an illustrated text.

A significant number of medical historians have recognized the artist's advancement in the study of anatomy and have repeatedly praised such painters and sculptors as Masaccio, Donatello, Mantegna, Verrocchio, and Pollaiuolo of the 1400s (during the Early Renaissance) along with Leonardo and Michelangelo of the 1500s (during the High Renaissance) for their realistic representation of the human form.[6] The fact that by the time Ketham's *Fasciculus* was published in 1491 the artist was already in advance of the physician in his knowledge of the human body can be explained by examining the education of the two professions. The training of the physician was primarily theoretical, emphasizing philosophical issues and taken at a university, particularly one that had distinguished itself in the teaching of medicine such as Bologna or Padua. The artist, in contrast, was apprenticed in a master's shop at the age of twelve to fourteen years and thereby learned his "trade" through practical application. Artists who distinguished themselves early in their apprenticeship—such as Leonardo, Michelangelo, and Raphael—either became chief assistants to the master or left the shop to pursue independent careers.

While the medical student was memorizing texts, the artist was drawing from nature, from classical models in the form of reliefs, and from statuettes and full-scale sculpture. The activity of

those studios or workshops (not the *studium* of the university), is described in numerous contracts and records that remain from the master's *bottega* or in the treatises written by artists who were literate although not university educated men.[7] In the earliest of these, the *Libro del'Arte* of Cennino D'Andrea Cennini, appears the first description of the proportions of man since the *Canon* of Polykleitos.[8] Writing in the late 1390s, Cennino was concerned with counting the bones in the human body; even though no number was supplied; following religious tenets he commented that the male has one less rib than the female. The character of Cennino's treatise is a practical one, containing, for the most part, instructions for grinding color, making brushes, and preparing tinted paper and other such supplies; nonetheless, his comments on anatomy reflect an interest in compiling data that describe the human form.

By comparison, the two editions of Leon Battista Alberti's treatise on painting—the Latin *De Pictura* of 1435 and the Italian *Della Pittura* of 1436, written one year after his trip to Florence with Pope Eugene IV, and the *De Statua* of 1464—are basically theoretical presentations. The interest in proportion and anatomy again are evidenced but have a more substantial role than in Cennino's work. In the *Della Pittura,* Alberti discussed the training of the artist and insisted on the use of anatomical study within the curriculum; he stated the need to begin from the bones, working from the skeleton up to the skin—thus clothing the skeletal armature with muscle and sinew. In order to make figures seem more natural and active—an ability that enabled the artist to rise from the position of artisan to that equal to the Humanists—he needed to know the attachment of the muscles, bones, and sinews.

It must be understood that Alberti's literary works, in particular the *Della Pittura* (which was widely read in manuscript form), exerted a significant impact on Italian art. It changed artistic pedagogy from practical to theoretical as well as assisted the artist's rise in social status from artisan to that of revered creator of nature. During the last decades of the fifteenth century, an expansion of Alberti's concept appeared in the work of such artists as Mantegna, Pollaiuolo, and his colleague Signorelli. Antonio Pollaiuolo is the individual who stands out at this time not only for his proficiency as a painter, sculptor, goldsmith, and printmaker, but for his study of the human form in action. His careful consideration of superficial anatomy, and the consistency with which he expressed that knowledge and his desire to show the figure moving through space, had a decisive impact on the career of Leonardo da Vinci, who is considered the first artist/anatomist.

Anatomy and Dissection

The genre scenes of the *Fasciculo*—including the unprecedented *Dissection* and those images derived from medieval manuscript illustrations—provide us with information on the "state of the art" of medicine during the late-fifteenth century.[9] Nonetheless, contemporary with those depictions are the dissection

activities of Leonardo da Vinci and Michelangelo. We know that Leonardo began his anatomical studies in Milan during the 1490s and that his younger contemporary is said also to have begun investigations of the human figure early in his career. However, it was the "competition" occasioned by their commissions for the decoration of the new Council Hall in the Palazzo Vecchio (City Hall) of Florence that revealed their extraordinary knowledge of the human form and that established them as knowledgeable anatomists. Their studies concentrated on myology and the antagonistic activity of bone and muscle. Figures in action rather than frozen in time and space were their concern.

Although the frescoes of both Leonardo and Michelangelo were left unfinished and are now lost to us (having been painted over by Giorgio Vasari in the 1560s at the order of Duke Cosimo I of Tuscany), engravings of those works were made by such contemporary artists as Marcantonio Raimondi, best known as the printer and press agent for Raphael. By 1510, Marcantonio had arrived in Rome, lured by its promise of fortune and fame. On the way from Bologna to Rome, he stopped in Florence, birthplace of the "new style" in the fifteenth century and still the center of significant artistic activity. By that time, Michelangelo had already left for Rome, but his cartoon for the *Battle of Cascina* (the Palazzo Vecchio Council Hall fresco) was still on view. From this "study in anatomy," as Michelangelo had called it, Raimondi engraved two prints known as *The Climbers*—one in ca. 1508 and the second in ca. 1510. It is important to note that Michelangelo's cartoons for the *Battle of Cascina* and Leonardo's *Battle of Anghiari* had such a great impact on the art of the sixteenth century that Giorgio Vasari declared they had become the "school of the world," only possible in Vasari's time because of the engraved images of these now-lost works.[10]

Locomotion in Art

All motion proceeds from the loss of equilibrium, that is equality of balance. . . . The stretching out of an arm drives the equilibrium of the body into the foot which sustains the whole weight, as is seen in those who, arms outstretched, can walk upon a rope.

Leonardo da Vinci[11]

The 1508 engraving of *The Climber* (Fig. 1) shows a highly muscled figure from the back as he scrambles up a riverbank. The skin is taut over the surface of the limbs and reveals muscle groups at the subcutaneous level, as seen in works by ancient Greek masters. His sense of locomotion and forward projection is evident as he raises his left leg to climb up the bank, while supporting his weight on his right leg so that the gluteus muscles are flexed. Simultaneously, he steadies his ascent with hands and arms placed to his right (on a diagonal with the raised leg), while his head is turned to the left as if wary of an assailant. The oblique view of the figure emphasizes the lower limbs and buttock and at the same time adds a curve that calls attention to the flexibility of the spine and the trapezius. The

Fig. 1. The Climber, *an engraving by Ramondi Marcantonio, ca. 1508*

(Courtesy of the Philadelphia Museum of Art, Le Grimpeur Montant sur le Rivage, *ca. 1510)*

tautness of the skin presents muscle groups seen not only in ancient works of art but the works of such fifteenth-century artists as Antonio Pollaiuolo, who admired the antique, and Leonardo and Michelangelo, who wanted to free the figure from the static *contrapposto* evident in *Disease Man* of Ketham's *Fasciculus* (Fig. 2). The *chiaroscuro*, or dramatic contrast, shown in the posterior of the torso strongly suggests an écorché study in which deeper muscles such as the rhomboids may be depicted. Since there can be little doubt about the date of the print and none concerning the period in which Michelangelo conceived the original composition, confirming this image as an écorché study would reinforce a link with the art studios of the late-fifteenth and early-sixteenth centuries as well as place the development of that figural type well in advance of the publication of Berengario's treatises.

In 1506 Leonardo completed the dissection of the Centenarian, a source for many of his écorché studies; in that same year Berengario began work on the *Commentaria*, which would be published in 1521. The most significant break of Berengario's work from Ketham's comes in the first six figures of the *Commentaria* and *Isagogae Breves*, which have muscle men as their foci. An examination of them reveals parallels between the interests of Berengario and the investigations of Leonardo da Vinci. Although a direct influence from Leonardo's anatomical drawings may be postulated,[12] the focus on myology is heavily weighted, and both the "muscle men" (Figs. 3–5) and the "action

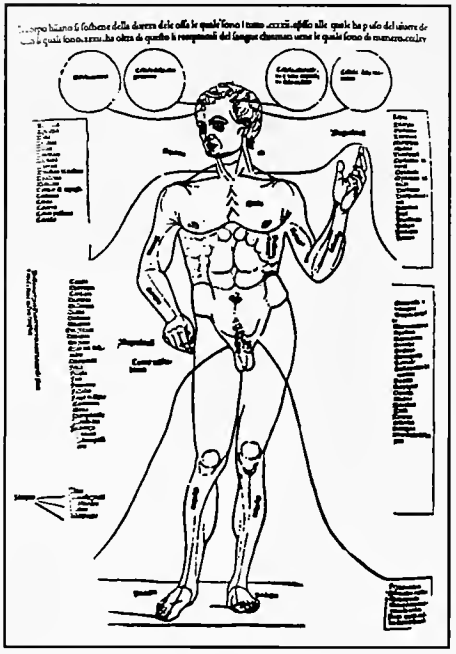


Fig. 2. Disease Man, *from Johannes Ketham's* Fasciculus Medicinae, *1491*

(Courtesy of the National Library of Medicine Collection)

Figs. 3–5.* Muscle Men, *from Berengario da Carpi's* Isagogae Breves *of 1523, demonstrate the muscles at descending levels within the abdomen.* From top: *Figure 3 depicts internal oblique ascending; Figure 4 depicts external oblique descending; and Figure 5 depicts a composite of the three forms of muscles—oblique, transverse, and the rectus abdominis.

(Courtesy of the National Library of Medicine Collection)

figures" (Figs. 8–12) suggest the central Italian preoccupation with the human form and its "academic" concern for *disegno* (drawing and design) more than Leonardo's search for ultimate truths and cosmological theorems. The degree of influence that Leonardo had on either the physician or the illustrator should not be discounted in the development of these unique illustrations. Yet, there is a sense of elegance and grace given to the figure that suggests the work of Raphael and the young Parmigianino and points to Ugo da Carpi, the purported illustrator of the treatises.

Berengario's *Commentaria*, published in Bologna, was the first illustrated book issued in the sixteenth century that had significance for the history of medicine equal to the works

of Ketham or the earlier Mondino de'Luzzi. But *Commentaria* is noted more for its illustrations than its text.[13] An examination of Berengario's use of visual images demonstrates how his work differs from that of Ketham, emphasizing his desire to present clearly the particulars of human anatomy and its myological system. Berengario's use of visual aids reveals clinical facts—an innovation because Renaissance physicians were more often preoccupied with literary endeavors than empirical observation.[14] Berengario's training as a surgeon and his expressed interest in the arts, more than his liberal arts degree in medicine, may have led him to illustrate his treatises; the information acquired from the observation of nature made his treatise useful to physician and artist alike. R. K. French has emphasized that Berengario's *Commentaria* provided a practical, not theoretical, guide to anatomy that was "dissection based."[15] That "hands-on" method underscores the significance that the skills of observation and dexterity had for both the artist and the physician. The medical man—or "*artifex*," as Berengario designated him—works, as does the artist, with eye and hand to describe in word or image his observations of the natural world. Along with a common orientation to the classics, a focus on direct observation, and the recording of information acquired from this activity provides a vehicle for interrelationship far more substantive than any formal guild association could offer.

French stressed that Berengario was an educated although practical surgeon who believed that careful observation could be of assistance in learning the truth of anatomy. His "*anatomia sensibilis*" was the anatomy of visible things that could be illustrated to reveal the clarity of the shape of organs and body parts as well as those areas difficult to see or that had the possibility of being damaged during a routine dissection.[16] With such an orientation towards nature, the classics, and art collecting it is not a surprise that Berengario would consider an illustrated volume. Moreover, Berengario admitted that he intended *Isagogae Breves* to be used by surgeons and artists for the study of anatomy. Clearly, by the 1520s, artistic interests were not only well established but artists themselves were considered good readership for the treatise.[17] It can also be said that Berengario not only provided the first systematic representation of the abdominal muscles, but also that he revealed the well-established use of the écorché and artistic models for the illustration of the medical text.

The frontispiece of the 1521 edition of the *Commentaria* displays a dissection scene with lector, prosector, and dissector, following the tradition of Ketham's *Dissection* in imitating the basic arrangements and hierarchy shown in the 1493 image. Clearly, Ketham's work was the inspiration for the 1521 frontispiece, but what were the sources for those illustrations that deviate from the Ketham model? Berengario's work shows no lingering of the late medieval tradition evident in such *Fasciculi* figures as *Wound Man*, *Disease Man*, or *Zodiac Man*. Instead, they display innovation and a close observation of nature in the *Muscle Men*

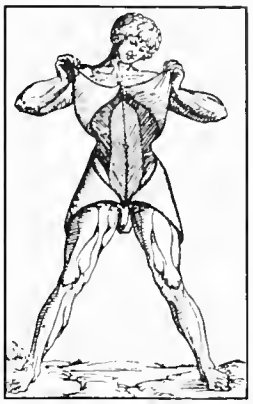


Fig. 3

Fig. 4

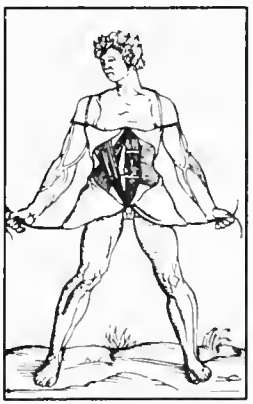


Fig. 5

and écorché figures. The illustrations of *Isagogae Breves* (1523) echo direct influence from High Renaissance masters and demonstrate the familiarity and exemplary status that the inventions of Leonardo, Michelangelo, and Raphael had acquired before the second quarter of the century. In the guise of the écorché, one recognizes Michelangelo's *David*, the *Ignudi* of the Sistine Chapel, and the serpentine figure of Leonardo's fertile mind as earlier demonstrated in Raimondi's *Climber*, who twists to the right while head and raised leg create a counter tension in the body. In every instance the artist's invention was to demonstrate the anatomy of motion. What better way than in the écorché!

In the six myological figures, both a rationale of muscle study and a chronology of the process of dissection are presented. If the physician had studied the cadaver in the pattern indicated by the images, he would have learned both the layering of the muscles and the procedure of dissection. The close observation and methodical presentation of the abdominal muscle layers has its verbal equivalent in Berengario's use of the term *demonstratio*, which forms a sympathetic chord between artist and physician. French underscores the surgeon's reliance on the senses but not to the exclusion of scholastic interests when he states: "Proof in anatomy is to expose the structure to the sight and touch . . . to a number of observers . . . in such a way that the reader can perform the dissection and employ his own senses."[18]

The similarity of the figures is enhanced by two additional observations:

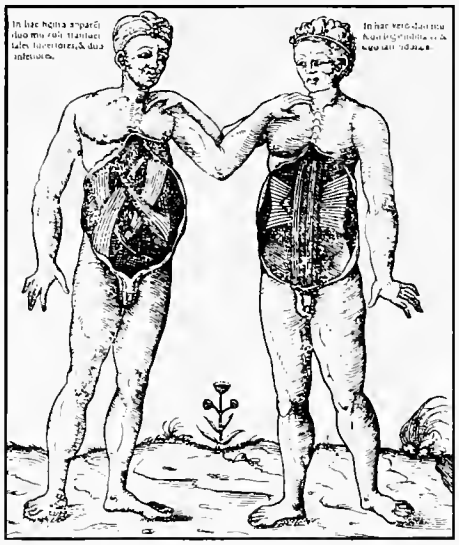


***Fig. 6. "The Twins," from Pietro d'Abano's* Conciliator Controversarium, *1565. An earlier version appeared in d'Abano's 1496* Conciliator Differentiarum.**

(Courtesy of the Historical Division of the Cleveland Health Sciences Library)

First, their consistency—they are all the same size, height, and bear the same basic physiognomy; second, their resemblance or kinship to the "twins" of the *Conciliator Differentiarum* of Pietro d'Abano (1496) of Venice (Fig. 6). This resemblance connects them with the medieval tradition of astrological medicine while providing a vehicle through which to present the complexities of the abdominal muscle layers.[19]

Berengario's illustrations go farther than those of d'Abano, however, providing not one but six images that systematically reveal the muscle groups below each other as they exist in nature. The heritage of d'Abano is reiterated in Berengario's sixth figure, a more schematic representation of the muscles that combines the two men of the *Conciliator* by showing the internal and external obliques, rectus abdominis, and the transversals in one figure.

In the six *Muscle Men*, the method of presentation by Berengario and his artistic designer considers both the didactic and aesthetic function of the illustrations. In terms of physiology, Figures 1 through 5 and the sixth "diagrammatic" image parallel, and therefore anticipate, the illustrations and procedures depicted in a modern dissection manual. Such information would have been available to anyone who, like Berengario, had dissected many bodies in post-mortem examinations. From examples of sections, a central incision along the *linea alba* appears standard and matches Berengario's illustrations.[20]

If the images in "Group One" of the treatises are medically oriented, those of "Group Two" are more aesthetically conceived and suggest a familiarity with the artistic milieu of the early-sixteenth century. With the exception of the *Skeleton* (Fig. 7), *Marasmic Man*, and *Crucified Man*, the positions and props for the remaining figures suggest studio models, sculptural figurines, or specific works of art as inspiration.

Both the *Striding Figure* and the *Man with the Plank* (Figs. 8-9) suggest the use of a live model in the studio, leaning on a staff or using the plank to steady such a long and demanding pose. *Man with the Rope* (Fig. 10), possibly inspired by Michelangelo's *David*, may also have been seen as either a live model draped with a rope to suggest the hangman's noose or—with *Man with the Axe* (Fig. 11)—may have been developed with the aid of a figurine as a reference; both depict a figure shown from more than one viewpoint, and not merely reversed as if the drawing had been turned over to move the figure 180 degrees.[21] Therefore, it is possible to say that not only could the David have been the inspiration for *Man with the Rope* and *Man with the Axe*, but also an écorché statuette that simulated the *contrapposto* of Michelangelo's *Giant* and may have been the resource for Ugo da Carpi the printmaker.

The same can be said for a figure from the 1523 *Isagogae* that turns and points into the distance, displaying his dorsal side (Fig. 12). The demonstration of the back muscles is purposeful in the complex, counterbalanced

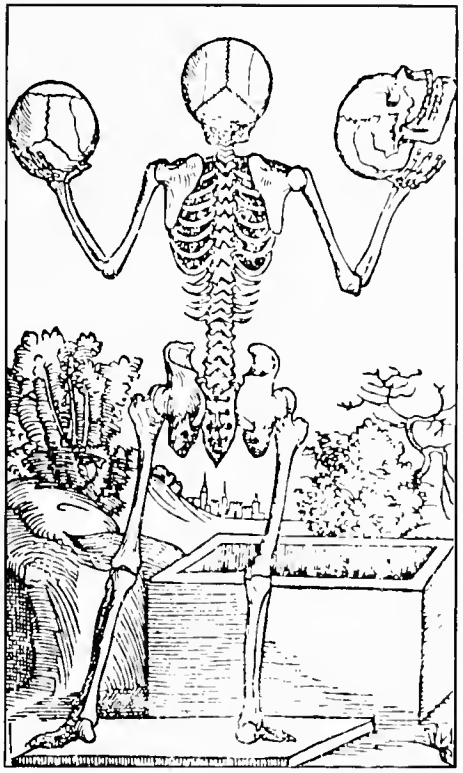


Fig. 7. Skeleton from the Rear, *from Berengario's* Isagogae Breves

(Courtesy of the National Library of Medicine Collection)

Fig. 8. Striding Figure, *depicting exterior lateral muscles, from* Isagogae Breves, *1522*

Figs. 8–11. These "action" and "artistic" figures from Berengario's Isagogae Breves *and* Commentaria *may have been inspired by studio models, sculptural figurines, or specific works of art. They marry accurate myology with animation, providing exemplars for artists and physicians.*

(Courtesy of the National Library of Medicine Collection)

Fig. 9. Man with the Plank, *depicting exterior lateral muscles, from* Commentaria, *1521*

Fig. 10. Man with the Rope, *depicting exterior anterior muscles, from* Isagogae Breves, *1523*

Fig. 11. Man with the Axe, *depicting exterior posterior muscles, from* Isagogae Breves, *1523*

Fig. 12. Twisting Figure, *depicting lateral muscles, from* Isagogae Breves, *1523*

(Courtesy of the National Library of Medicine Collection)

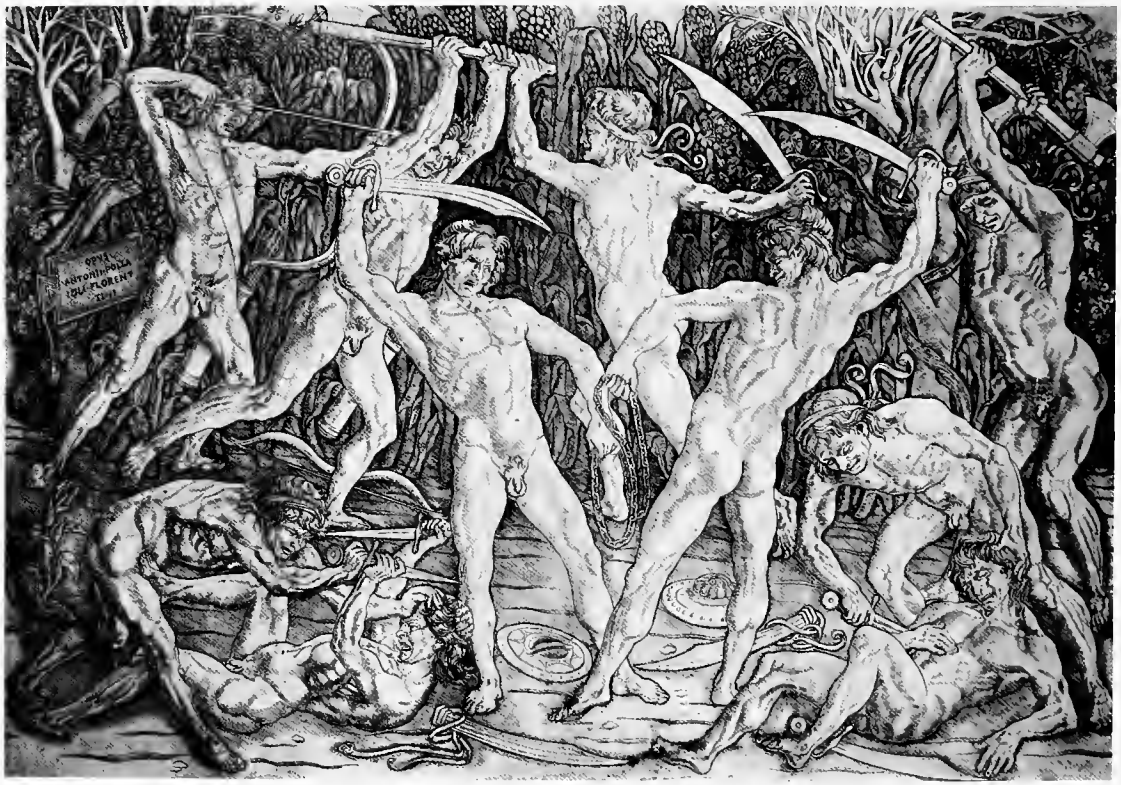
contrapposto of this figure, and recalls the figures in Michelangelo's *Battle of Cascina* and the Sistine *Ignudi*—surely, both familiar to Ugo da Carpi.

Berengario was a renowned surgeon who was believed to have dissected many cadavers, but the fact that his "action figures" are accurate écorché figures suggests the use of life models. This commonplace pedagogical tool used in the fifteenth-century studio was codified as part of the curriculum for training the artist after 1563, when the Accademia del Disegno was established in Florence by Giorgio Vasari.

It is worthwhile to note that mannequins of one sort or another were used by the fifteenth-century artist as models from which to develop compositions for painting and sculpture. Wax was used extensively to model works to be executed in bronze; there is evidence for the use of wax-figure models in the workshops of both Verrocchio and Pollaiuolo. Two prints of the Art Academy of Baccio Bandinelli show activities that were *de riguer* for the academy. The earlier of the two prints, executed in 1531 by Agostino Veneziano, shows the Bandinelli workshop in the Belvedere of the Vatican Palace (Fig. 13). The artists work by candlelight, studying and drawing from écorché figures and statuettes that have both a strong classical influence and an emphatic myology.[22] It is interesting that masters as well as pupils participated and that both are drawing from sculptures. The scene cannot be that of a "night class," for there is sufficient evidence from the period that artists understood that studying objects in strong light increased the relief of the figure, particularly the relief of the muscles. A 1550 print of the Bandinelli studio in Florence indicates two illuminating sources—firelight and candlelight—as well as écorché figurines, skeletons, and classical statuettes. Thus, as early as 1531—less than a decade after the publication of *Isagogae Breves*—it was standard for classes to draw from statuettes and écorché figures under strong light; such exercises heightened plasticity of the form and isolated individual muscle groups in a manner familiar from Antonio

Fig. 13. **The Academy of Baccio Bandinelli,** ***an engraving by Agostino Veneziano***

(Courtesy of The Metropolitan Museum of Art, Elisha Whittelsey Collection, Elisha Whittelsey Fund, 1949, 49.97.144)



Pollaiuolo's *Battle of the Naked Men* engraving (Figs. 14-16) and the drawing of the *Warrior Model*.

That Berengario's work reflects the new trends of the *cinquecento* as expressed in Leonardo's motion and anatomy studies has been underscored by Robert Herrlinger and others.[23] Leonardo demonstrated his separation from the Albertian mind-set not only in his discussion of light and color but also in his depiction of the figure in space. Both Alberti and Leonardo, however, stressed the importance of the plasticity of the figure. In the *Della Pittura* of 1436, Alberti made recommendations for the artists' accomplishments in rendering the properties of relief with the suggestion that it was better to work from a mediocre sculptural model than from a fine painting.[24] The practice of working from three-dimensional models of wax or clay under controlled light in order to perfect the plasticity of the

Fig. 14. **The Battle of the Naked Men,** ***an engraving by Antonio Pollaiuolo, ca. 1470. Mirror images and multiple views imply the use of sculptural models.***

(Courtesy of The Cleveland Museum of Art, purchased from the J. H. Wade Fund, 67.127)

body and simulate natural conditions became a studio practice in the fifteenth century. Alberti observed, as did Leonardo, that cast shadows differ in accordance with the light source; furthermore, he stated that light from natural bodies—such as the sun, the moon, and the Venus star—created shadows equal to the body that interrupt the light, whereas light from a fire will distort those shadows by attenuating them.[25] Leonardo took up the same issue in his discussion of depicting relief by recommending specific over universal light. He stated: "Of those lights which should give a true perception of the shape of the muscles, the universal ones are not good, but specific lights are perfect, and the more so, the smaller in shape these lights are."[26]

While Alberti insisted on the recreation of a realistic form and observed the relationship of the shadow to the object, Leonardo was even more particular on the use of appropriate light sources for desired levels of relief. As has been demonstrated, his recommendations were adhered to in the Bandinelli studio.

It is common knowledge that despite the impact of Alberti's theories and recommended practices, his power over the artist had begun to wane during the last quarter of the fifteenth century. This is most evident in the depiction of strong emotions and violent action as depicted in Pollaiuolo's *Battle* engraving or Mantegna's *Sea Gods*. Such displays exceeded the Albertian decorum of the figure, as did the turning and twisting of the body that became a primary element in the work of Leonardo

Fig. 15. Detail from Battle of the Naked Men

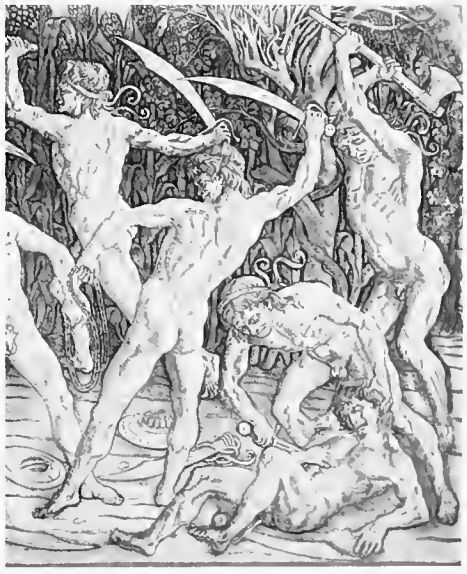


Fig. 16. Detail from Battle of the Naked Men

Figs. 17–18. **Fallen Warrior,** ***attributed to Giovanni Francesco Rustici, ca. 1520, black beeswax on metal wires mounted on a block of wood, 22.2 x 14.2 cm. Because of its small size, the model could be turned easily in different directions, perhaps along with a variety of models. As Leon Battista Alberti had written in*** **De Pictura** ***in 1435: "I prefer you to take as your model a . . . sculpture . . . for from a sculpture we learn to represent both likeness and incidence of light."***

(Courtesy of The Cleveland Museum of Art, John L. Severance Fund, 63.576)

and Michelangelo as a result of their motion studies and dissection activity.

The Verrocchio studio, in which Leonardo was apprenticed, garnered fame from the creation of such works as *The Doubting Thomas* for Or San Michele and the *Colleoni Monument*. Despite the success of the equestrian bronze, Verrocchio was criticized by his contemporaries for the too-specific anatomy and unpleasing "flayed" appearance of the horse. In both the diagonal movement of Thomas, the raised arm of Christ, and the animation and power of Colleoni, there is a sense of mobility and displacement of space greater than had been seen even in Donatello's work. Such expressive vitality can be accounted for by the use of wax and clay models and mannequins with limbs that could be moved by means of a wire armature. Although most of these *modelli* have disappeared, the Cleveland Museum of Art is fortunate to have one in wax, the écorché of a fallen warrior (Figs. 17-18). Until recently it had been attributed to Leonardo and associated with his design for both *The Battle of Anghiari* and the Sforza and Trivulzio equestrian projects. The *bozzetto* has been assigned recently to Rustici, a follower of Bertoldo who had been Michelangelo's master.[27] Rustici collaborated with Leonardo on sculptural projects in Florence in the first decades of the *cinquecento*. Despite the reassessment of this work, one can consider it a close substitute for the models used both in the Verrocchio studio and the *bottega* of its great rivals, the Pollaiuolo brothers, both of whom were sculptors and goldsmiths.

The wax has been darkened to enhance the readability of the écorché and

has a wire armature that would have made it possible to position the figure as the sculptor might desire to best fit his composition or present design. Prominent are muscle groups in the chest, lower leg, shoulder, and back. The figure also is shown twisting at the waist, and the spiral of the body echoes the pose created by Leonardo to enhance the display of the antagonistic action of muscle and bone. As in Raimondi's *Climber* (Fig. 1), the points of the figure that sustain weight (such as the right arm and hand, and most likely the right leg) demonstrate the flexing of the muscles where the stress is greatest. The treatment of the back muscles is strikingly similar to the pose of *The Climber* accounted for in the engagement of the right leg and the twisting of the torso. The model is small (22.2 x 14.2 cm) and can therefore be turned in different directions—perhaps in company with other similar sculptures to create the complex patterns of a proposed composition, such as the battle scenes executed by Leonardo.

Laurie Fusco has described Pollaiuolo's working method as consisting of classical sculpture, the moveable model known as the *Warrior Model*, and live models.[28] Johann Meder believed that Antonio Pollaiuolo had used écorché statuettes to plan the composition for the *Battle* engraving, and the scholar Sofia Ameisenowa has suggested that one could reconstruct the models themselves from the print.[29] A. Hyatt Mayor proposed that these mannequins were wax with moveable arms and that the mirrored action in the composition of the *Battle* engraving reinforced the idea that Pollaiuolo had done dissections.[30] I do not intend to resolve the question of Antonio's activity in the dissection of the human figure, for that has been so well presented by Fusco and Bernard Schultz,[31] but I do hope to add a consideration both to the issue of his dissection activity and his use of statuettes.

The shallow depth of field in the *Battle* print is like that of Roman sarcophagi as demonstrated by an example from the third century of *The Vengeance of Orestes* (Figs. 19-20) now in the Cleveland Museum of Art. In this sequential narrative, one sees the the hero Orestes twice as he goes from matricide to exoneration by Apollo. At the center of the composition, the hero's arm is across his body as he draws the sword from his scabbard and turns his head abruptly to the right towards his foe. His right knee is bent, and it appears that the muscles of his thigh are flexed not only to support him but ready for new activity and locomotion. There are similar elements in the Pollaiuolo engraving, but the demonstration of muscles seems more of a presentation piece of knowledge than an organic whole. The pleasing proportions of the battling men and a sense of sequence as found in the Roman work is suggested in the print, thus demonstrating a reliance on the antique but not a knowledge of kinetic anatomy. That he includes muscles that would not be visible in a given pose or that may have been added to heighten the sense of movement, strengthens the arguments of both Laurie Fusco and L. Price Amerson, Jr., who have concluded that Pollaiuolo did minimal dissection.[32]

Fig. 19. **Sarcophagus with Cover: The Vengeance of Orestes, *Roman, third century***

(Courtesy of The Cleveland Museum of Art, gift of the John Huntington Art and Polytechnic Trust, 28.856)

The silvery grey light of the Cleveland Museum impression, which is the earliest known extant example of the first state of this print, suggests the controlled environment of the artist's studio. The manner in which the muscles "pop up" to isolate themselves from the surface suggests that the artist used a sculptural model or models, perhaps combined with careful observation of the live model. For motion he could have relied on Roman relief sculpture because tradition in the fifteenth-century studio did not include a series of stop-action poses from the model, as one might see today in a drawing or painting class.

In summary, the treatment of the muscles in the *Battle* engraving by Pollaiuolo, the Cleveland wax *modello*, and the criticized equestrian monument of Verrocchio suggests the possibility of the existence of the écorché figure in the late-fifteenth-century studio. Such images as Raimondi's print of the *Climber*, Leonardo's and Michelangelo's anatomy studies, and particularly the illustrations of Berengario's *Isagogae Breves* attest to the fact that écorché models existed in the artist's studio well before the middle of the sixteenth century. This realization suggests that Pollaiuolo, the first thought to have dissected, may have learned myology by a composite of studio practices, including the study of well-articulated (most probably classical) statuettes under strong light rather than by the use of a scalpel. Still needed is an explanation for Vasari's claim that Pollaiuolo dissected many bodies. Perhaps Vasari based his statement on his own reliance on dissection as an integral part of the training of the artist at mid-century, or perhaps Pollaiuolo's works known to him but lost to us suggested or affirmed the notion.

Nonetheless, these manifestations alert us to the primary importance that artistic practice had for the physician in the Pre-Vesalian era, that seminal period of medical illustration during which medieval practices were sloughed off, first by the artist and then by the physician.

It is evident that in order to create the most accurate and aesthetic illustration for treatises on anatomy, the artist selected from a variety of resources: illustrations in earlier medical treatises, examples from the antique, and work executed by contemporaries that provided either solutions in composition or presentation of form. The result was a composite that echoes the interests of the High Renaissance and Mannerism evolving in Florence and Rome before the Sack of Rome by French troops in 1527.

As illustrations became more specific and empirical, the artist's selection process also mirrored something of the relationship and interests of artist and physician during the period of 1491-1543. Although specific data is still lacking for a direct sharing of information gathered from dissection between Berengario and his printmaker Ugo da Carpi—or even how the two came together, there is ample ground to establish a common purpose for artist and physician. In order to present greater accuracy and "truth to nature," the two had to share their knowledge.

The physician's desire to be ranked as one of the literary humanists and the artist's aim to become a creator of images equal to those found in nature drew the two professionals together.

Fig. 20. Detail of **Orestes Slaying Clytemnestra**

(Courtesy of The Cleveland Museum of Art, gift of the John Huntington Art and Polytechnic Trust, 28.856)

As for those painters and sculptors who flocked around me at my dissections, I never allowed myself to get worked up about them to the point of feeling that I was less favored about these men for all their superior airs.

Andreas Vesalius[34]
China Root Letter, 1546

■

Notes

1. Leonardo da Vinci, *Quaderni d'Anatomia*, 1: 13v, as cited in H. Hopstock, "Leonardo as Anatomist" (trans. E. A. Fleming), in *Studies in the History and Method of Science*, ed. Charles S. Singer, 2 vols. (Oxford, Eng.: Clarendon Press, 1917–1921), 2: 155.

2. Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early Modern Europe*, 2 vols. (Cambridge, Eng.: Cambridge University Press, 1980), 1: 3–12 et passim.

3. Ibid., pp. 246–47, 566–74 et passim.

4. E. C. Streeter, "The Role of Certain Florentines in the History of Anatomy, Artistic and Practical," *Bulletin of the Johns Hopkins Hospital* 17 (1916): 113–18; Charles Singer, "Notes on Renaissance Artists and Practical Anatomy," *Journal of the History of Medicine* 5 (1950): 156–62.

5. Fielding H. Garrison, *The Principles of Anatomic Illustration before Vesalius* (New York: Paul B. Hoeber, Inc., 1925), pp. 43–46. On the relationship of Donatello and Chellini, see R. W. Lightbrown, "G. Chellini, Donatello and Antonio Rossellino," *The Burlington Magazine* (London) 104 (1968): 102–4, and John Wyndham Pope-Hennessey, *The Study and Criticism of Italian Sculpture* (New York: Metropolitan Museum of Art and Princeton University Press, 1980), pp. 85–87 et passim.

6. Streeter, pp. 113–18; Singer, "Notes on Renaissance Artists," pp. 156–62.

7. Among the exceptions is the distinguished author Leon Battista Alberti, who had a university education in law and ultimately became part of the Papal Curia of Eugene IV before he became an architectural designer. Alberti's contemporary Lorenzo Ghiberti (who is praised in the foreword of the *Della Pittura)*, was inspired by Alberti to write his own treatise or *Commentarii* in the years 1444–1445 modeled after Pliny and Vitruvius; Ghiberti's third book was modeled after Alhazen and Avicenna. In his first book Alberti recommended the viewing of an anatomy so that the artist would know the "bones, muscles, nerves and sinews." See Leon Battista Alberti, *On Painting and On Sculpture*, ed. Cecil Grayson (New York: Phaidon, 1972), pp. 74–75; Creighton E. Gilbert, *Italian Art 1400–1500: Sources and Documents in the History of Art*, ed. Horst W. Janson (Englewood Cliffs, NJ: Prentice Hall, 1980), p. 63; Bernard Schultz, *Art and Anatomy in Renaissance Italy* (Ann Arbor, MI: UMI Research Press, 1985), pp. 35–36.

8. The *Canon* was cited by Galen in *De Placitis Hippocratis et Platonis* and *De Temperamentis* as the model of *symmetia* or proportion representing the perfect model for the sculptor of the fifth century B.C.; see J. J. Pollitt, *The Art of Greece, 1400–31 B.C.: Sources and Documents* (Englewood Cliffs, NJ: Prentice-Hall, 1964), p. 89; Schultz, p. 11; and Roslynne V. Wilson, *Collaborations in Art and Medicine, 1491–1543: The Development of Anatomical Studies in Italian Medical Treatises* (Ann Arbor, MI: University Microfilms, 1989), pp. 170, 196n.

9. Charles Singer, trans., *The Fasciculus Medicinae of Johannes de Ketham Alemanus*, with introduction by Karl Sudhoff, No. 9 in Monumenta Medica series (Milan: R. Lier & Co., 1924); *Fasciculo di Medicina*, with an introduction by Charles Singer, Monumenta Medica Series, 2 vols. (Florence: R. Lier and Co., 1925).

10. Suzanne Boorsch, *Italian Masters of the Sixteenth Century*, Vol. 28 of Adam von Bartsch, *The Illustrated Bartsch* (New York: Abaris Press, 1985), pp. 87–90; Cecil Gould, *Michelangelo: The Battle of Cascina*

(Newcastle-upon-Tyne, Eng.: University Press, 1966).

11. Leonardo da Vinci, as cited in Kenneth D. Keele, "Leonardo Da Vinci's Influence on Renaissance Anatomy," *Medical History* 8 (1964): 367.

12. Robert Herrlinger, *History of Medical Illustration from Antiquity to 1600* (New York: Editions Medicina Rara, 1970), pp. 70–74, 83; Singer, "Notes on Renaissance Artists," p. 158; Sigrid Braunfels-Esche, ed., *Leonardo da Vinci, das Anatomische Werk* (Basel: Holbein Verlag, 1954), pp. 62–63.

13. R. K. French, Andrew Wear, and Iain M. Lonie, *The Medical Renaissance of the Sixteenth Century* (Cambridge, Eng.: Cambridge University Press, 1985), pp. 61–62.

14. Katherine Park, *Doctors and Medicine in Early Renaissance Florence* (Princeton, NJ: Princeton University Press, 1985), p. 237; Richard J. Durling, "A Chronological Census of Renaissance Editions and Translations of Galen," *Journal of the Warburg and Courtauld Institute* (London) 24 (1961): 230–305; Edwin H. Ackerknecht, *A Short History of Medicine*, rev. ed. (Baltimore: Johns Hopkins University Press, 1982), pp. 95–96.

15. French et al., pp. 52–53.

16. Ibid., pp. 56–58.

17. Ibid., p. 62; L. R. Lind, trans., *Jacopo Berengario da Carpi: A Short Introduction to Anatomy (Isogogae Breves)* (Chicago: University of Chicago Press, 1959), p. 24.

18. French et al., pp. 52–53.

19. H. Bober, "The Zodical Miniature of the *Tres Riches Heures* of the Duke de Berry—Its Sources and Meaning," *Journal of the Warburg and Courtauld Institute* (London) 11 (1948): 1–34; Roslynne V. Wilson, *Collaborations*, pp. 98–102; Wilson, "The Gemini and Berengario's Muscle Men," unpublished paper read at the Central Renaissance Conference, Kansas City, MO, Spring, 1989.

20. Eberhardt K. Sauerland, *Grant's* Dissector, 9th ed. (Baltimore: Williams & Wilkins, 1984); Figs. 2.6 and 2.8 (pp. 29, 30) show myological diagrams of muscle layers as depicted in Berengario's illustrations. See also Lind, trans., *Isogogae Breves*, pp. 16, 23–26; K. P. Russel, "Jacopo Berengario da Carpi," *Australian and New Zealand Journal of Surgery* 22 (1953): 70.

21. Laurie Fusco, "The Use of Sculptural Models by Painters in Fifteenth-Century Italy," *Art Bulletin of the College Art Association of America* 64 (1982): 175–194.

22. Edward J. Olszewski, "Distortions, Shadows, and Conventions in Sixteenth Century Italian Art," *Artibus et Historiae* (Venice), nr. 11, 6 (1985): 103.

23. Herrlinger, pp. 70–74, 83; Singer, "Notes on Renaissance Artists," p. 158; Esche, pp. 62–63; Lind, p. 24.

24. Leon Battista Alberti, *On Painting*, trans. John R. Spencer (New Haven, CN: Yale University Press, 1956), pp. 94–95; Olszewski, p. 117. For Leonardo on the use of sculptural relief, especially for anatomical study, see Mosche Barasch, *Light and Color in the Italian Renaissance Theory of Art* (New York: New York University Press, 1978), pp. 19 passim.

25. Barasch, pp. 19 passim; Grayson, p. 101.

26. Barasch, p. 84, n. 69.

27. Patrick M. de Winter, "Recent Accessions of Italian Renaissance Decorative Arts," *Bulletin of the Cleveland Museum of Art* 73 (1986): 161–63.

28. Fusco, "The Use of Sculptural Models," pp. 178–80.

29. L. K. Amerson, *The Problem of the Ecorche: A Catalogue Raisonne of Models and Statuettes from the Sixteenth Century and Later Periods*, Ph.D. Diss., Pennsylvania State University (Ann Arbor, MI: University Microfilms, 1975), pp. 2–32, particularly p. 5, n. 10 and p. 9, n. 29.

30. A. Hyatt Mayor, "Artists as Anatomists," *Bulletin of the Metropolitan*

Museum of Art 22 (1964): 205.

31. Fusco, "The Nude as Protagonist: Pollaiuolo's Figural Style Explicated by Leonardo's Study of Static Anatomy, Movement and Figural Anatomy," Ph.D. Diss., New York University, 1978, pp. 145–49; Schultz, pp. 51–65 et passim; Amerson, pp. 8–9, nn. 26, 27.

32. Fusco, "The Use of Sculptural Models," pp. 185–86; Amerson, p. 10.

33. Andreas Vesalius, *China Root Letter* (1546), as cited by Streeter, pp. 116–17, and in brief by A. Hyatt Mayor, *Artists and Anatomists* (New York: The Artist's Limited Edition,1964), p. 102.

Roslynne V. Wilson is Associate Professor of Liberal Arts at the Cleveland Institute of Art. Previously she was Curator of Education at the Cincinnati Art Museum. This article is based on her 1989 dissertation completed at Case Western Reserve University and later research delivered at the 1991 Annual Meeting of the American Association for the History of Medicine. She now divides her explorations in the Italian High Renaissance between the history of medical illustration and the development of sixteenth-century landscape drawing.

Her dual interests in the scientific and artistic character of the High Renaissance are reflected in a current study project on selected works in the collection of the Cleveland Museum of Art. Her analysis of the anatomical drawings of Battista Franco and Bartolommeo Torre da Arezzo and the landscapes of Domenico Campagnola and Fra Bartolommeo will be included in a compendium of Italian Renaissance drawings in Midwest collections to be published by the Midwest Art History Society.

Leonardo da Vinci's Anatomy Revisited

Leonardo da Vinci lived in a most thrilling age. The first book with movable print appeared when he was one year old. Throughout his lifetime, there was a deluge of scientific books. He was forty years of age when Columbus navigated across the Atlantic. He knewAmerigo Vespucci quite well, and the two would sit together in conversation for hours and hours; in 1506 he painted a portrait of Vespucci, but that painting—along with so many others of importance—is lost. In 1517, near the end of his life, Leonardo heard about Martin Luther's bold hammering of ninety-five theses to the door of the Wittenberg castle church (in Hamlet's university town), which forever changed views about the Bible, religion—and life altogether. In Germany and Hungary it was the age of revolt against governmental authority. People of science started to feel free to think for themselves, not to be bound by dictum of ancient authority. Even the great untouchables of medieval times—Aristotle and Galen—were looked upon with critical eyes.

Self-portrait by Leonardo da Vinci

Realism in Art

Leonardo's contemporaries in Florence imbued him with the same ideals in painting: Observe reality as is and give it an esthetic form, but first see for yourself. In order to perceive things realistically, Brunelleschi, the architect,

by T. Doby

and Donatello, the sculptor, rambled in Rome with a ruler in their hands, measuring proportions not as they seemed, but as they were. The Pollaiuolo brothers dissected corpses, and their studies were attended by their student Verrocchio, Leonardo's later master.

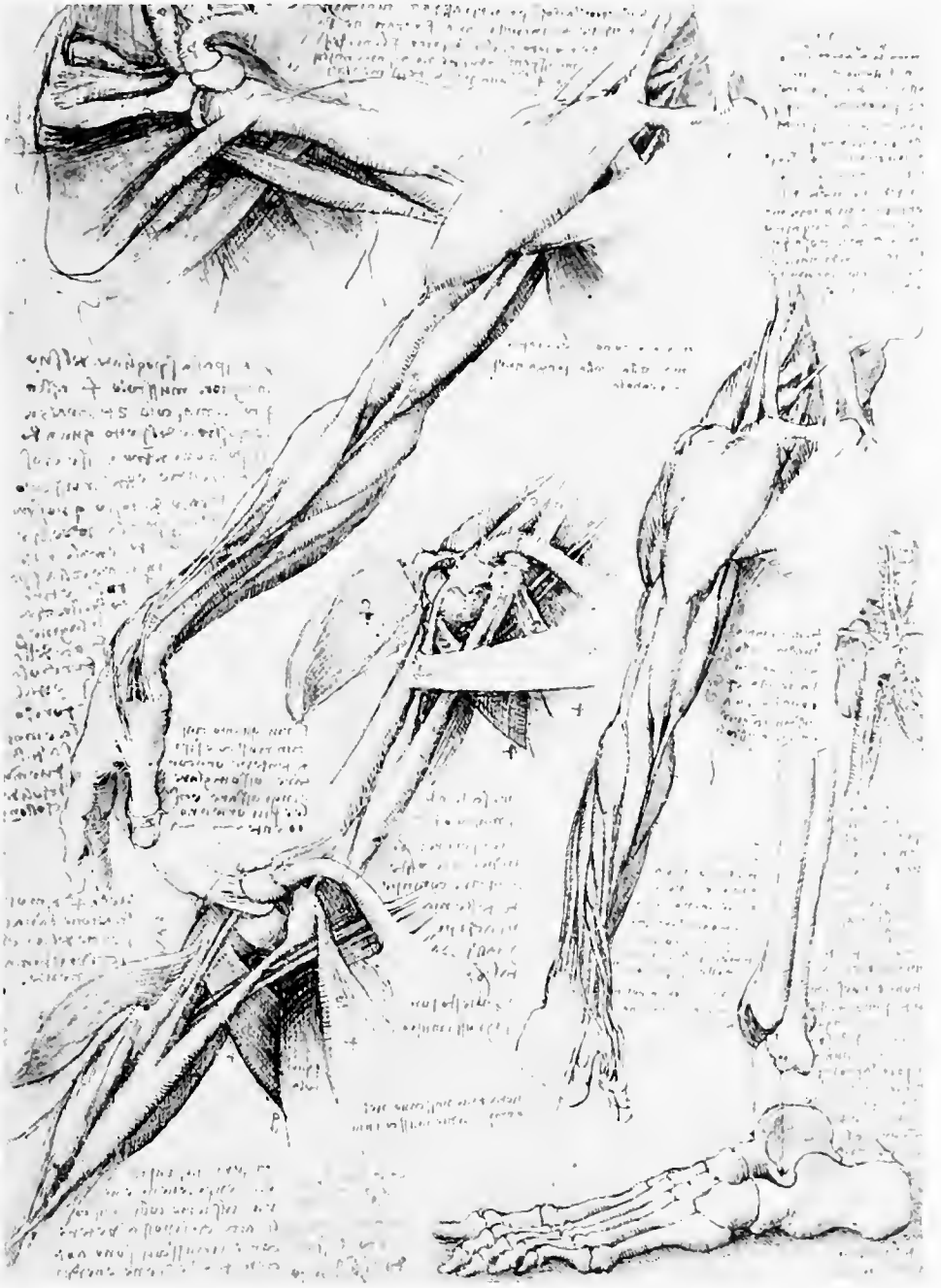
Leonardo first pursued anatomical studies for artistic ends. Only later, when discouraged by personal disasters, did he resort more and more to scientific endeavors. In 1500, at the peak of his professional career as an artist, he escaped for dear life before the invading French army in Milan; at about the same time he learned of the destruction of the clay model of his celebrated equestrian statue, which the victorious soldiers used for target shooting. Seven years later, faulty technique resulted in the deterioration of his unfinished dynamic wall painting in the Florence town hall. The invitation by the new lord of Milan proved to be futile, and intrigues of the papal court in Rome between 1513 and 1515 made his life miserable. All in all, unstable circumstances after the downfall of Lodovico Sforza and Leonardo's own delaying and procrastinating working habits prevented him from finding the permanent patron who would give him the security of opportunity and income that went to the more fortunate Michelangelo and Raphael.

Scientific Observation

Estrangement from the arts set in gradually to the benefit of the sciences. It was to Leonardo's advantage that he was not trained in medicine, for he thus avoided being indoctrinated by forced views or phony concepts. He formed his own opinions, which frequently clashed with the views of accepted authorities. Nevertheless, because of his fascination with anatomy, he read widely; as more questions presented themselves, he had to turn to respected sources. Leonardo constantly looked for information related to his studies, buying books or borrowing them from friends. An inventory taken in 1504 listed 116 scientific treatises in his possession. He pursued his studies with meticulous care, always with perfectionist tendencies. "I had to proceed by stages with many bodies to achieve complete knowledge," he wrote, "I did this twice in order to understand the differences." He demonstrated "each part from three different aspects."[1] He listed as aids for his dissections "spectacles, with cardboard, Steel and fork . . . charcoal, drawing board, sheets of paper and pencil, pipe clay and wax, thongs and quarrel, small-toothed saw, chisel, etc."[2] He prepared the regions with the greatest care, using running water or lime water to cleanse each surface.[3]

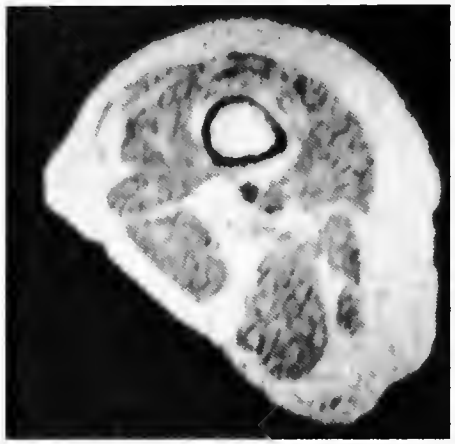
Portrayal of Muscles and Bones

Mastery of muscles and bones was a chief goal for any artist. Leonardo held surface anatomy so important for the depiction of human objects that his early sketches for *The Last Supper* show the apostles and Christ nude, in order to correctly portray the bodies accurately before the addition of clothes. His anatomical studies showed muscles from all angles "as if you had the same member in your hand and went on turning it



Leonardo's depiction of shoulder muscles, from Dell' Anatomia Fogli A, *14v*

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)



Cross section of the leg by magnetic resonance imaging showing muscles and fluid in suprapatellar bursa

(Maine Magnetic Imaging, Portland)

gradually until you had a complete understanding of what you wish to know,"[4] the way muscles are represented in modern textbooks.

As a student of mechanics, Leonardo made reference to the forces of muscles related to their energy and direction of pull, explaining for instance the work of intercostal muscles.[5] But he emphasized that "only (the muscles) which act are to be shown and the more forcibly they act, the stronger they should be pronounced. Those that do not act at all, must remain soft and flat" (probably a hint to Michelangelo, his adversary, who frequently misrepresented reality by showing muscles at the height of action, regardless of the position of the limb).[6]

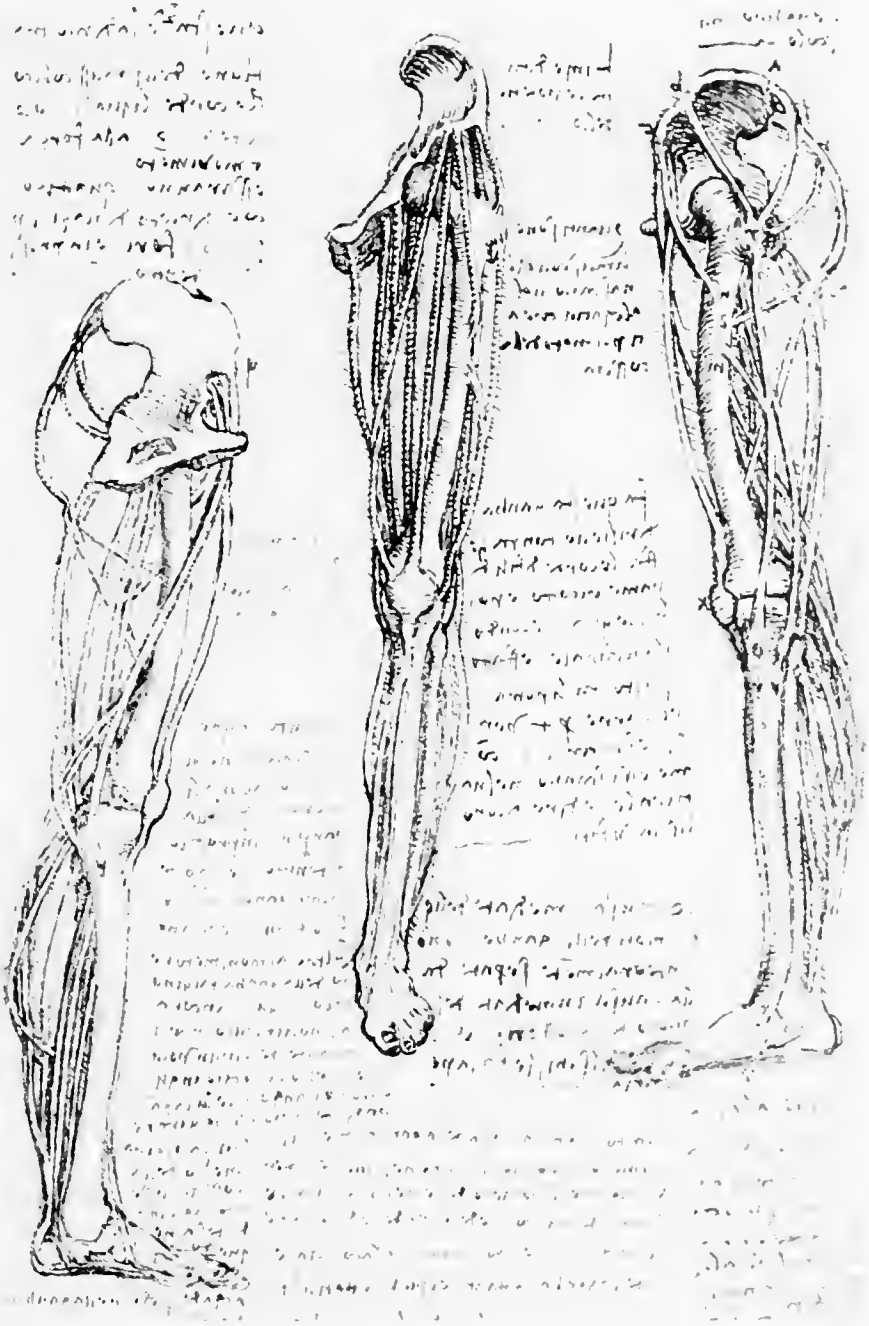
Leonardo wondered how one could illustrate muscles and still demonstrate their spacial relationships to each other: the problem was that overlying muscles concealed the ones below. His solution was to substitute a string for each muscle; in this way, the deep-lying muscle was not obstructed by the overlying one.

A second solution was to portray a cross section of the limb, which would not only show the relationship between the muscles but also indicate the nerves and vessels running between them. Before Leonardo, nobody had thought about such a representation. Only much later did anatomy books employ the same approach.

His demonstration of bones showed several firsts: the proper number of vertebrae, the lordotic and lumbar curves of the spine, the angle of the femur to the pelvis, the angle of the femoral neck to the shaft, the metacarpals and phalanges, the skull with the paranasal sinuses. He described his methods for looking into the inside of the bones "which must be sawn through to

Leonardo's cross section of the leg, from* Quaderni d'Anatomia, *V: 20r

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)



Leonardo's depiction of the leg muscles, from Quaderni d'Anatomia, *V: 4r*

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)

demonstrate which are hollow and which are not, which are medullary, which are spongy, etc. etc."[7] The difference between his drawings and others of the time is stunning.

Leonardo's treatment of the muscles is probably the most detailed of his opus. Even his discussion of the alimentary tract begins with the entrance: the muscles of the lips. His acute attention to minutiae and his penchant for dealing with proportions—so important for the artist—becomes evident. The mathematician, the maniac obsessed with figures, observed: "The maximum shortening of which the mouth is capable is equal to half of its greatest extension and is equal to the greatest length of the nostrils of the nose and of the interval interposed between the lacrimators [naso-lacrimal ducts] of the eyes."[8]

Portrayal of the Abdomen

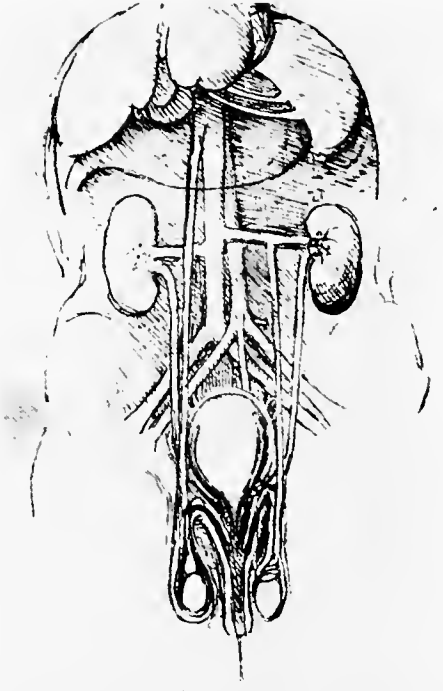
Leonardo was not aware of the peristaltic movements of the bowels, but in order to perceive their windings he blew them up with air—proof of his inclination for experiments. The depiction of the abdominal organs is almost faultless compared to the ridiculous illustrations of the time.[9]

He portrayed the liver with the proper proportions, not a pitiful caricature of reality with five equal peels of slices representing the five lobes. Leonardo's textual elaborations on the bladder and ureters are not very convincing, yet his drawings of them are superb.[10] His opinion on the erection of the penis was derived from his examination of hanged criminals; contrary to prevailing teaching that air was responsible, he credited vascular engorgement.[11]

The prize for his genito-urinary investigations goes to the representation of a fetus *in utero* in the third trimester. The developing baby's fetal position, the umbilical cord in the single uterus (contrary to current teaching of a double or multiple compartments) is perfectly demonstrated. The fetus is shown from right, from left, and from the front according to his strategy of anatomical demonstration.[12]

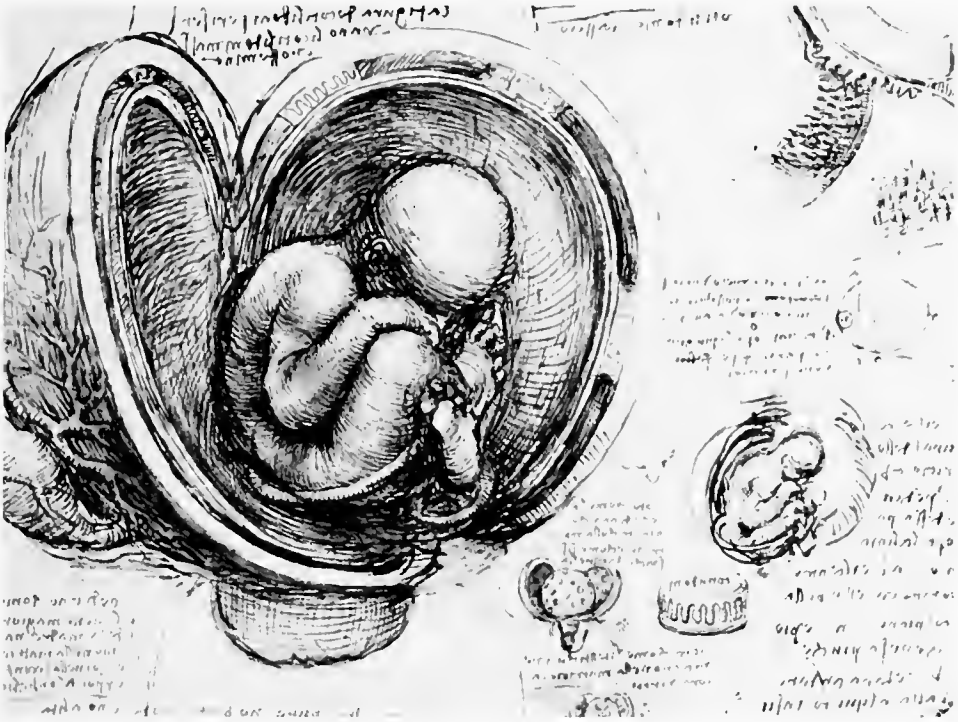
Portrayal of the Nervous System

Leonardo's portrayal of the nervous system over a fifteen-year period



Detail of Leonardo's depiction of abdominal organs, from* Quaderni d'Anatomia, *III: 5r

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)

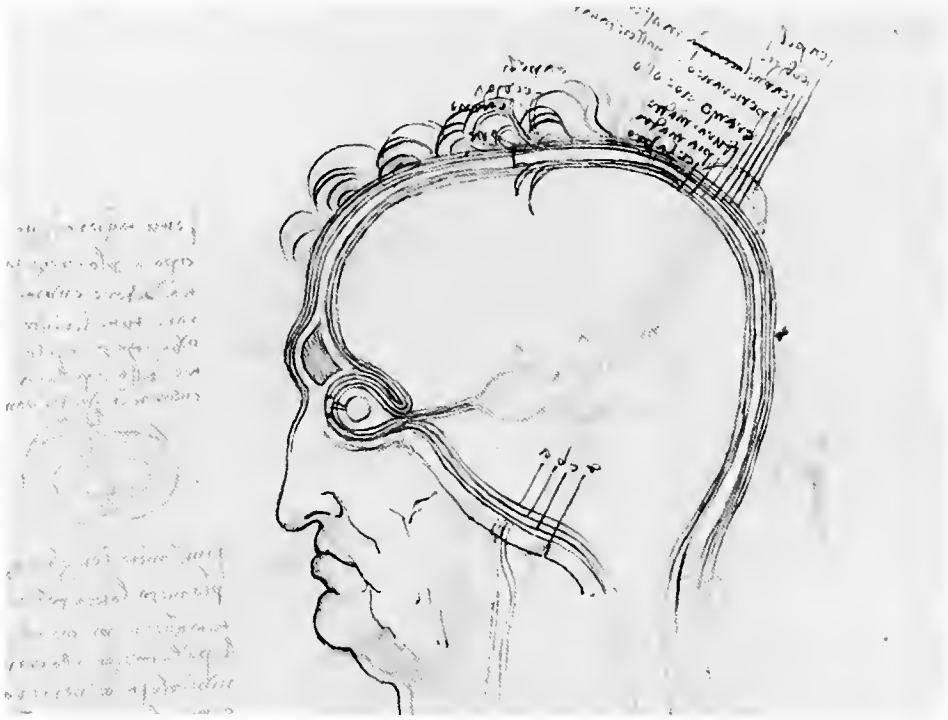


Detail of Leonardo's depiction of the fetus in utero, *from* Quaderni d'Anatomia, *III: 8r*

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)

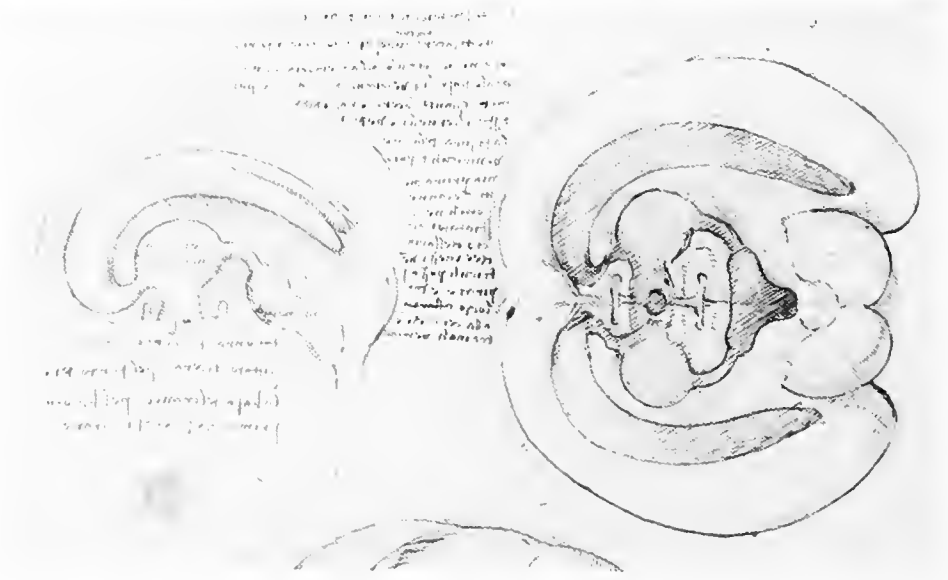
illustrates his early reliance on classical writers and his later correction of their work. His first description of the brachial plexus in 1490 (instigated by Galen, the uncontested source in his times) is full of faults, but by 1506 he had crafted an almost perfect drawing based on his own findings.[13] Modern critics Charles D. O'Malley and J. B. Saunders, who do not allow enthusiasm to take over when they scrutinize the anatomical works of Leonardo, have called it "the most accurate representation of the findings in man."[14] Leonardo was also the first to show the abducent nerve in the orbit, not described by Galen.[15]

But Leonardo made mistakes as well. He extended the spinal cord all the way down to the end of the spinal canal instead of finishing it at the level of the second lumbar vertebra—a mistake repeated by Vesalius.[16] Much of his interest in the spinal cord derived from his studies that the nerves "are clearly seen to arise entirely from the medulla"—contrary to Aristotle, who declared that everything had its origin in the heart.[17] Leonardo confirmed this with experimentation with a live frog, which died "immediately" when its spinal medulla was pricked: "And previously it lived without head, without heart and entrails or intestines or



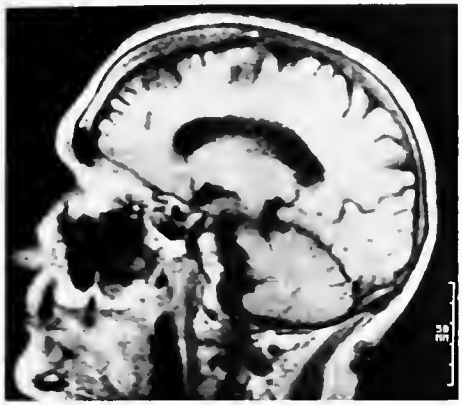
Detail of Leonardo's concept of the cerebral ventricles, showing the influence of ancient authors, in the 1490s from Quaderni d'Anatomia, *V: 6v*

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)



Leonardo's wax cast of cerebral ventricles years later, from Quaderni d'Anatomia, *V: 7r*

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)



Ventricles of the human brain as demonstrated by magnetic resonance imaging

(Maine Magnetic Imaging, Portland)

skin. It thus seems that here lies the foundation of motion and life."[18] The sympathetic chain in the upper thoracic area, although described by Galen, was drawn first by Leonardo.[19]

His contemporaries believed—following Galen and medieval Arabic sources—that the functional centers of the nervous system were the cerebral ventricles themselves. As dissection of the human brain was not practiced, description and illustrations (even decades after Leonardo) were erroneous—three distinct compartments situated in the sagittal direction, like lemons in a row. The anterior compartment was supposed to be the center of fantasy and intellect, the middle one that of thinking and judgment, and the posterior that of memory and voluntary movements. Leonardo's readings induced him to follow the descriptions, and he drew a picture accordingly.[20]

But how long could Leonardo follow the writings of authorities, when his own opinion was: "To me it seems that those sciences are vain and full of errors which are not born by experience, mother of all certainty."[21] His study of the brain resulted in a major technical invention. When he cut into it, he found compartments very different from what he had been led to expect. But how to draw a void, a something that is not there, a hollow cave with only a jello-like substance surrounding it, which changed its shape with every touch? His practice in sculpture helped him out. He was thoroughly familiar with the process of making death masks as well as with the properties of wax, an important material for making sculptures or bronze casts. Wax could be liquified at warm temperatures yet froze solid if cooled to room temperature. He made a cast of the ventricles of an ox with these instructions: "Make two vents in the horns of the great ventricles and inject melted wax with a syringe, making a hole in the ventricle of memoria (fourth ventricle) and through such a hole fill the three ventricles of the brain. Then when the wax has set, take away the brain and you will see the shape of the ventricles perfectly. But first put narrow tubes into the vents so that the air which is in these ventricles can escape and make room for the wax which enters into the ventricles." (Eventually, he applied his findings to a human head).[22] Leonardo's mentioning of air was erroneous, for the ventricles contain fluid, not air; nevertheless, his description was a vast improvement over his predecessors. Also, by introducing liquid that later solidified, he invented a technique for showing empty compartments—a technique still used for corrosion preparations. Filling cavities with a substance to show the

shape of the empty space is employed a thousand times a day in radiological examinations.

Optics and the eye with the lens and its refraction power were of course of prime interest for Leonardo the artist as well as the scientist. But the inside structures of the eye always collapsed after the vitreous escaped through the cut surface. To provide support and hold all structures in their original relationship to each other, without falling apart after dissection, Leonardo put the eye into egg white and boiled the assemblage. In this way he maintained the position and original relationships of the structures—he hoped—otherwise, they would separate. Although in this arrangement the lens still moved away from its natural place, Leonardo had nevertheless invented the technique of embedding used today in anatomy and microscopy.[23]

Portrayal of Respiration

Following Galen's teaching, contemporaries believed that air entered through the lung into the heart "to cool it" and that there was also a small amount of air between the chest wall and the lung. Respiration intrigued Leonardo in all respects. He went into lengthy explanations about the mechanics of respiration; he drew numerous diagrams about its mechanics with the role of the intercostal muscles, the diaphragm, and the serratus muscles.[24]

Leonardo's scientific fervor in pursuing the question about the connection of the function of the heart and lungs is manifested in the following lines: "First make the ramification of the lung [the bronchial tree] and then the ramification of the heart, that is of its veins and arteries. Afterwards make the third ramification of the combination of one ramification with the other. You will make these combinations from four aspects and you will do the same for the said ramification so that there will be twelve. Then make a view of each from above and one from below, that there will be in all eighteen demonstrations."[25] As he advanced with his own studies, he exclaimed an opinion contrary to Galen's dictum: "It seems to me impossible that any amount of air whatsoever should be able to enter the heart, through the trachea, for if we try to inflate the heart, we will be unable to blow any air out of it [the tracheal," and he expressed doubts "whether any quantity of air is interposed between the lung and the chest."[26]

Portrayal of the Cardiovascular System

As his life went on, more and more interruptions crossed his way. After his flight from Milan in 1500, the next years were spent in constant moving from city to city. At the end of his second Milanese period, changing political leadership between 1508 and 1513 erupted in public disturbances in the streets; the death in 1511 of his admirer and protector, the French governor Charles d'Amboise, rendered his existence quite uncertain. Those circumstances turned Leonardo with increased intensity toward the sciences and particularly toward anatomy. Those were the years with his most mature investigations in

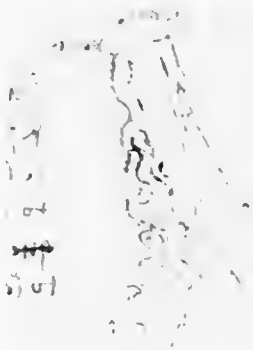
anatomy, particularly the cardiovascular system.

His first remarkable study on the cardiovascular system dates back to 1504–1506 in Florence, where the brethren of the Hospital of Santa Maria Nuova allowed him to undertake anatomical studies, contrary to the claims of historians who state that such activities were suppressed by the Inquisition. Even fifty years later, in the hotbed of Inquisition Spain, the University of Salamanca not only prescribed that "It is the duty of the lecturer to provide human bodies without stoppage and to perform dissections," but recommended the reading of Vesalius's book based on dissections.[27]

Meanwhile, Leonardo, absorbed in the composition of the *Battle of Anghiari* and the painting of the *Mona Lisa*, found time to pursue his anatomical studies in the hospital. "An old man only a few hours before he died, told me that he had lived for one hundred years without experiencing any physical failure or weakness, and sitting there on the bed in the hospital . . . he passed from this life giving no sign of any accident. And I dissected his body in order to understand the cause of so easy a death and I found that the blood in the arteries nourishing the heart and the rest of the body had decomposed and dried up. In my examination of a two-year-old boy I found everything quite different."[28] In another place he wrote: "With advancing age the blood vessels lose their straight course and become increasingly twisted and bent as well as thicker. The question arises why the vessels should become winding where they were straight before and why their walls should thicken to such an extent as to hinder or prevent the flow of blood and whether without any actual disease, this might in itself be the cause of death in old people. . . . These old people gradually are crumbling away and are using up their life force in the absence of nourishment."[29]

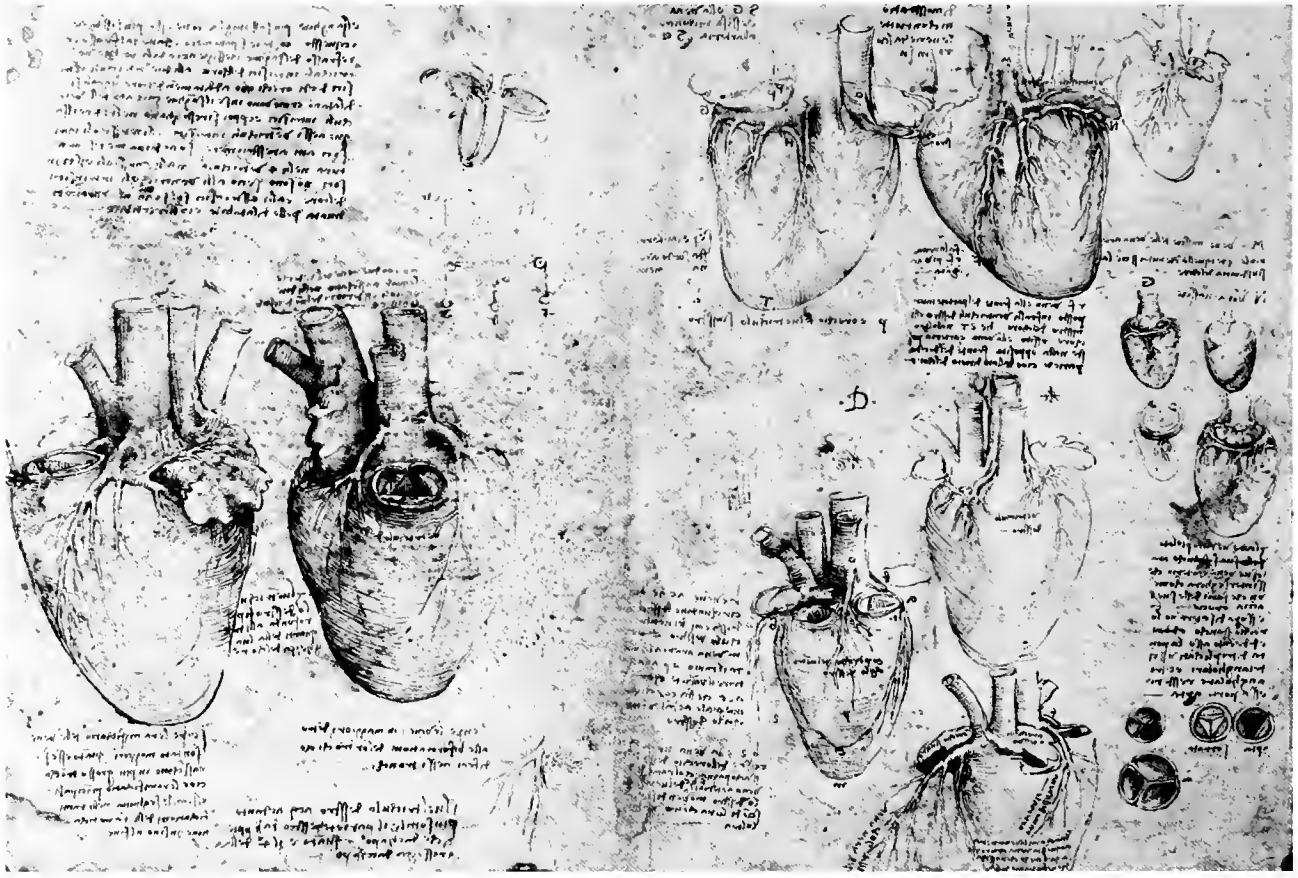
After years of interruption, he took up the study of the heart in Milan in the 1510s, primarily with an ox's heart because he did not have a supply of human corpses. An examination of Leonardo's voluminous reflections and drawings of the heart have led some admirers to declare that he understood blood circulation.[30] That is completely unfounded, however. Leonardo followed Galen's description of ebb and flow, flux and reflux in the blood vessels. That type of movement and the opening and closing of the valves was sometimes incomprehensible for a mind so thoroughly acquainted with hydrodynamics, but it had to wait for another century to be clarified by Harvey.

Leonardo's drawings of the surface of the heart are detailed and beautiful, especially when compared with contemporary works. The inside depictions of the heart should receive particular praise; the papillary muscles and the fibrae tendineae with their function explained are all excellent. In one of the pages he shows a band of muscle across the right ventricle "to prevent it to be over-distended." On the same page Leonardo made a quick sketch of a hole found between the two auricles, a foramen ovale or an interatrial septal defect, which he intended



Detail of Leonardo's demonstration of old and young vessels side by side, from* Dell' Anatomia Fogli B, *10r

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)



***Some of Leonardo's numerous depictions of the heart, from* Quaderni d'Anatomia, II: 4r**

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)

to check "whether it occurs in other auricles."[31]

The movements and function of the valves intrigued him beyond anything. Ever fascinated with the movements of waters, watching currents influenced by bordering walls or obstacles in their flow, he devoted several pages of his manuscripts to the semilunar valves.[32]

But how could he watch the currents of blood and their influence on the closing of the valves in the heart? How could he see this in action? He found the answer: "A plaster mould to be blown with thin glass inside and then break it from head to foot . . . but first pour wax into this valve of a bull's heart so that you may see the true shape of this valve."[33]

In this glass model (anticipating the description of the "sinuses of Valsalva" by almost two hundred years), he observed the currents with the aid of glass seeds. To explain the movements of the semilunar valves, he glued "membranes" to the appropriate places. His

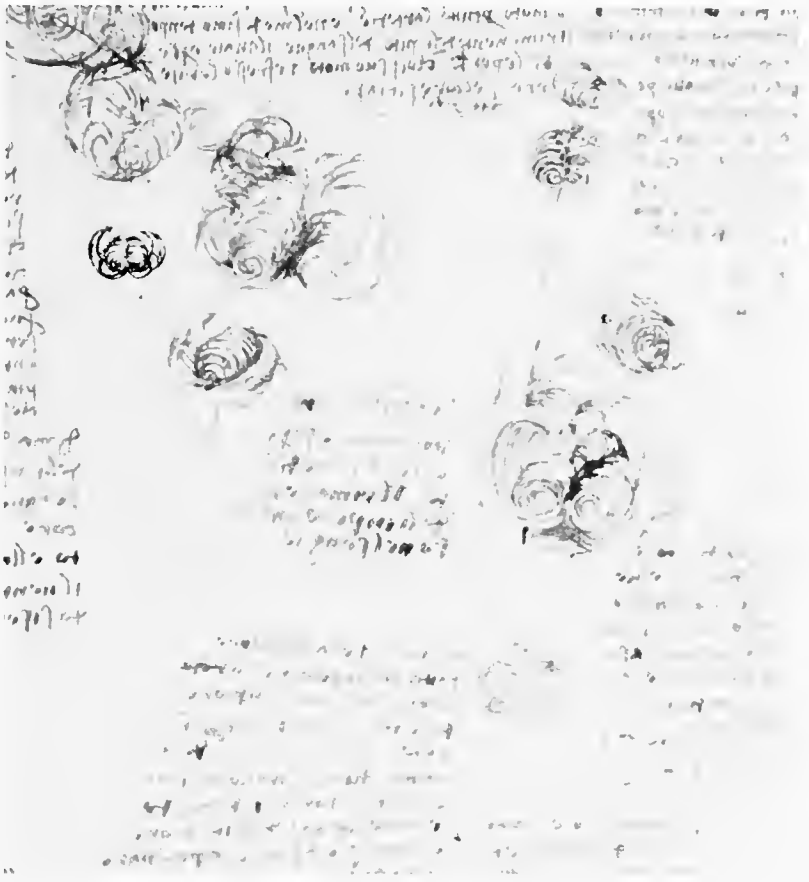
drawings are remarkably identical to (but unknown by) those produced in a glass model by Wieting in 1972 and by Dotter and Frische with Roentgenological technique in 1958.[34]

Leonardo recognized the heart as a muscle, and therefore he looked for the nerve supply. "Follow up the reversive nerves (vagus) as far as the heart and observe whether these nerves give movement to the heart or whether the heart moves of itself," he wrote.[35] Although an agnostic, he could not repress his feelings when he observed, "A marvelous instrument, invention of the supreme Master."[36]

On the pulse he wrote: "The beating of the heart generates a wave of blood through all vessels which continually dilate and contract. The dilatation occurs on the reception of super abundant blood."[37] With peripheral vessels he was correct many times, but also incorrect a number of times. For instance, he let the right main pulmonary artery branch communicate with the superior vena cava, which is obviously false. On the other hand, his treatment of the celiac axis, the portal veins and the hepatic veins, is fair.

Conclusion

After all these excellent observations, exciting technical innovations, and marvelous foresights, what has happened to the pages where they were expressed? In 1510, Leonardo jotted down in his notebook: "This winter I look to finish all this anatomy."[38] Then at another place he almost begged: "Concerning the advantage which I would like to hand down to mankind, I shall teach you a process of systematic printing and I ask you, my successors, not to let yourselves be turned aside by motives of jealousy from making such prints."[39] Although he designed an improved printing press,[40] he was far from being able to print a book, which would have involved a finalized text with considerable editing as well as sorting and redoing illustrations in wood or copper and preparing a reference sheet. The project required time, organization, and money. Did his overpowering self



***Detail of Leonardo's glass replica showing the primary and secondary whirls above the valves, from* Quaderni d'Anatomia, II: 13v**

(Windsor Castle, Royal Library. © 1992, Her Majesty Queen Elizabeth II)

confidence run away with him again? The words of Vasari come to mind: "He talked about more things than he actually accomplished."[41]

In 1778 the Windsor collection of his anatomical drawings was numbered at 779; the extant number is only six hundred. (How many were lost before 1778 cannot be guessed.) Destroyed or misplaced sheets might have shown the more finalized—and therefore the more valuable—versions of his studies, which perhaps had been removed or sold. Because the *Codex Madrid* was found only in 1965 at the forgotten bottom of a library shelf, is it possible that the missing pages are also only hiding somewhere?

Unfortunately, Francesco Melzi, Leonardo's heir, did nothing with the treasure he had in his hands. The few artists who saw the superb drawings did not understand their medical value. Moreover, none of Leonardo's contemporaries could read his miniature reverse writing. With quiet patience and concentration, industrious workers without the stunning talents of Leonardo eventually reached the same results. Vesalius, for example, had not seen the diagrams—and was probably unaware of them—when he wrote his epoch-making work on anatomy thirty years later. Only after four centuries did Leonardo's anatomical studies become known to a wider audience.

In our day and age we take for granted things Leonardo saw or depicted. With our technology we routinely use his ingenious techniques, albeit in different forms. We can demonstrate his original views of muscles with magnetic resonance imaging. We can show blood currents and the brain with a host of modern machinery in life, not in corpses or models only. But if we look back, we have to admire the unique intellect who first saw them or designed them, five hundred years ago.

■

Notes

1. Leonardo da Vinci, *Codice Atlantico* (Milan: Hoepli, 1894–1904), folio 13v (hereafter cited as *Codex Atlanticus*); Leonardo da Vinci, *Quaderni d'Anatomia*, ed. O. C. L. Vangensten, A. Fonahn, and H. Hopstock, 6 vols. (Christiania: J. Dybwad, 1911–1916), I: 2–8 (hereafter cited as *Quaderni d'Anatomia*).

2. *Quaderni d'Anatomia*, I: 13v.

3. Ibid., I: 1–8.

4. Ibid., I: 2–8.

5. Leonardo da Vinci, *I manoscritti di Leonardo da Vinci della Reale Biblioteca di Windsor: Dell' anatomia fogli A*, published by T. Sabachnikoff, transcribed and annotated by G. Piumati (Paris: E. Rouveyre, 1898), 16v (hereafter cited as *Fogli A*).

6. Leonardo da Vinci, *Trattato della pittura, con aggiunte tratte dal Codice vaticano publicato da Guglielmo Manzi* (Milan: Societa tip. de'classici italiani, 1859), Ch. 55.

7. *Quaderni d'Anatomia*, I: 2–8.

8. Leonardo da Vinci, *I manoscritti di Leonardo da Vinci della Reale Biblioteca di Windsor: Dell' anatomia fogli B*, published by T. Sabachnikoff, transcribed and annotated by G. Piumati (Turin: Roux and Viarengo, 1901), 38v (hereafter cited as *Fogli B*).

9. Ibid., 2v.

10. Ibid., 14r.

11. Ibid., 2v.

12. *Quaderni d'Anatomia*, III: 7r.

13. *Fogli B*, 4v, 3v.

14. Charles D. O'Malley and J. B. de C. M. Saunders, *Leonardo da Vinci on the Human Body: The Anatomical, Physiological, and Embryological Drawings of Leonardo da Vinci* (1952; rpt. New York: Greenwich House Inc., 1982), p. 358.

15. *Fogli B*, 35r.

16. *Quaderni d'Anatomia*, IV: 9r.

17. *Fogli B*, 17v.

18. *Quaderni d'Anatomia*, V: 21v.

19. *Fogli B*, 3v.

20. *Quaderni d'Anatomia*, V: 6r.

21. *Trattato della pittura*, as cited in Kenneth Clark, *Leonardo da Vinci* (New York: Penguin Books, 1976), p. 84.

22. *Quaderni d'Anatomia*, V: 7.

23. *Codex Atlanticus*, 345v.

24. *Fogli B*, 27v.

25. Ibid., 37v.

26. *Quaderni d'Anatomia*, II: 1r, 7v.

27. Stephen D'Irsay, *Histoire des Universites Francaises et Etrangeres* (Paris: Picard, 1933).

28. *Fogli B*, 10v.

29. Ibid., 11v.

30. Filippo Bottazzi, "Leonardo as Physiologist," in *Leonardo da Vinci* (New York: Reynal and Co., 1956), p. 384.

31. *Quaderni d'Anatomia*, II: 11r; O'Malley and Saunders, p. 244.

32. *Quaderni d'Anatomia*, II: 9v; Kenneth D. Keele, "Leonardo da Vinci's 'Anatomia Naturale,'" *Yale Journal of Biology and Medicine* 52 (1979): 369–409; Francis Robicsek, "Leonardo da Vinci and the Sinuses of Valsava," *Annals of Thoracic Surgery* 52 (1991): 328–35.

33. *Quaderni d'Anatomia*, II: 13v.

34. Ibid., IV: 11v; Harvey Greenfield and Willem Kolff, "The Prosthetic Heart Valve and Computer Graphics," JAMA 219 (1972): 69; T. Doby, *Development of Angiography* (Littleton, MA: Publishing Sciences Group, 1976), pp. 4–8; Charles T. Dotter and Louis H. Frische, "Radiologic Technique for Qualitative and Quantitative Study of Blood Flow," *Circulation* 18 (1958): 961–69.

35. *Quaderni d'Anatomia*, IV: 7r.

36. *Fogli B*, 12r.

37. Ibid., 28r.

38. *Fogli A*, 17r.

39. Ibid., 8v.

40. *Codex Atlanticus*, 358r.b.

41. Giorgio Vasari, *Vita di Lionardo da Vinci 1568*, translated and annotated by Ludwig Goldscheider (London: Phaidon Press; New York: Oxford University Press, 1944), p.12.

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Depth Studies: Illustrated Anatomies from Vesalius to Vicq d'Azyr

"Depth Studies: Illustrated Anatomies from Vesalius to Vicq d'Azyr," an exhibition comprising approximately thirty illustrated anatomy texts, was on view at the David and Alfred Smart Museum of Art from March 17 through June 7, 1992. The exhibition grew out of a graduate seminar in the Department of Art, the Department of History, and the Morris Fishbein Center for the History of Science and Medicine, under the direction of Professor Barbara Maria Stafford of the Department of Art.

The books featured in "Depth Studies" were on loan from the Department of Special Collections of the Joseph Regenstein Library of the University of Chicago. The exhibition was organized in conjunction with the University of Chicago Centennial Conference, "Imaging the Body: Art and Science in Modern Culture," held at the University on April 2–4, 1992. Essays and plate descriptions are reprinted with the permission of Barbara Maria Stafford and the David and Alfred Smart Museum of Art.

Special thanks are due to the following members of the Smart Museum: Stephanie D'Alessandro, Assistant Curator; Rudy Bernal, Preparator; Bruce Linn, Britt Salvesen, and Lilianna Sekula, graduate interns; and Helen Halpern and Joseph Shure, volunteers. Kimbeth Coventry, Exhibition and Conservation Coordinator of Special Collections at the University of Chicago Library, provided valuable assistance.

"Depth Studies" was funded in part by the Illinois Arts Council, a state agency.

by Barbara Maria Stafford
Elizabeth Klein Katherine Haskins
Elizabeth Liebman Tracy Teslow

Depth Studies

by Barbara Maria Stafford

According to Galen (130–200 A.D.), anatomy is "an opening up in order to see deeper or hidden parts." The exhibition "Depth Studies: Illustrated Anatomies from Vesalius to Vicq d'Azyr" explores diverse ways in which illustrated anatomy texts from the Renaissance to the late Enlightenment fathomed the invisible or concealed realms of biology and physiology. These composite books ranged from small, portable manuals for private use to folio editions employed in teaching physicians, surgeons, and artists in the fine points of human architecture on a life-size scale. As physical objects, such volumes evoke an almost cinematic sense of narrative: through the activity of turning the pages the body itself becomes a book, a serial composition constantly destroyed and created before the viewer's eyes.

Structure is unfolded in a horizontal sequence of images recording the hand's vertical descent, its methodical division of part from whole. Gradual revelation is also implicit in the probing that gives graphic shape to unseen form and function. Making manifest is a sort of visual archaeology. As the dissector dug deeper into the corpse, he exposed a mutable organism at once unified and fragmented, simple and complex, ideal and grotesque.

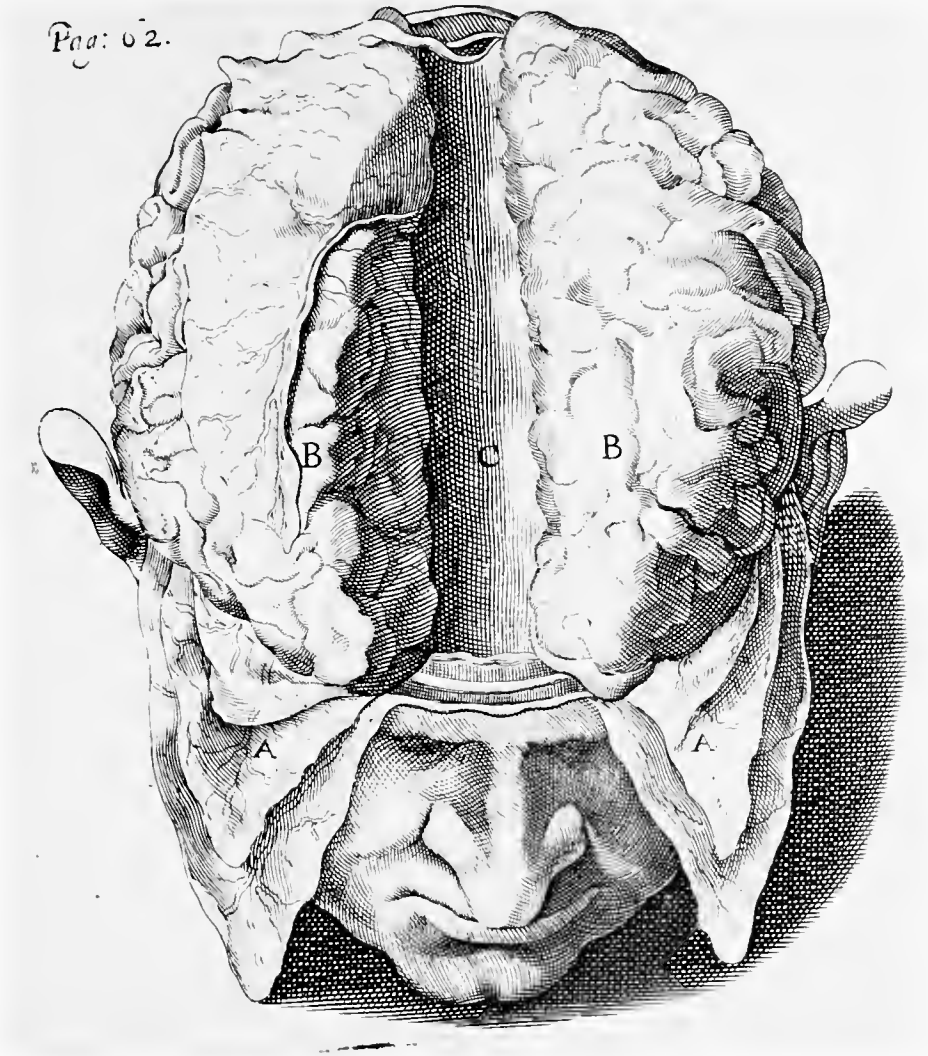
Anatomy as the manual study of depths relied on ancient dichotomies that were also hierarchies: outside/inside, material/immaterial, appearance/essence, and surface/ground. The juxtaposition of violent opposites as well as the discovery of order by means of the knife gave rise to evocative metaphors, and peeling or stripping away thus came to characterize the rational or analytical method for knowing nature both in general and in particular. Similarly, eighteenth-century physiognomic theories and nineteenth-century phrenological systems continued to restrain wayward and chaotic flesh through measured grids. Conversely, dramatic and pathos-laden Baroque poses corresponded to a moral universe in which the agony and vulnerability of the uncontrollable body were the wages of sin. In the heroically-sized plates of Albinus, medicine joins martyrology.

The tension between an emotional, illusionistic staging of death and its supposedly impersonal, empirical documentation stretches from the emblematic frontispieces of Vesalius to the cool mapping of cadavers by Vicq d'Azyr.

The Renaissance: Opening the Body

by Elizabeth Klein

"In the great felicity of this age . . . with all studies greatly revitalized, anatomy has begun to raise its head from profound gloom, so that it may be said without contradiction that it seems almost to have recovered its ancient brilliance in some universities . . . . If (dissection) does not attain a fuller development among us than ever before . . . at least it may reach such a point that one can assert without shame that the present science of anatomy is comparable to that of the ancients and that in



Petri Paaw (1564–1617), Dutch professor of anatomy

Succenturiatus anatomicus continens commentaria in Hippocratem [Anatomy with commentary on Hippocrates]. Bound with *Primitiae anatomicae...* (Lyons: Iodocum a Colster, 1616.)

"Figura ostendens que pacto cerebrum anterius bisidum sit" [The anterior form of the brain displayed]

Engraving, John Crerar Collection of Rare Books in the History of Science and Medicine, University of Chicago Library

Although this illustration of the brain is found in a commentary on a Hippocratic medical text, the image is copied from a woodcut in Vesalius' *De humani corporis fabrica* of 1543 and is a testimony to the widespread influence of Vesalian imagery on later anatomies. Here, the engraving technique endows the illustration with a clarity not present in the woodcut. However, the work retains the Vesalian device of depicting the opened head with a dignified human face. The work is a forebear of the Baroque *écorchés*, in which skin is peeled back in a dramatic gesture that not only reveals the organs beneath but also conveys the unseen pathos of the human subject.

our age nothing has been so degraded and then wholly restored as anatomy."
Andreas Vesalius
Preface to *De humani corporis fabrica*, 1543

Scientific thinkers of the Renaissance plumbed two depths in seeking knowledge: ancient authorities, many of whose texts were found and translated during the period, and nature.

The late medieval period witnessed the first opening of the cadaver since antiquity. In 1316, Mondino de Luzzi (c. 1275–1326) performed a dissection in Bologna. Dissections, however, were used primarily to confirm authorities such as Aristotle (384–322 B.C.), whose system of natural philosophy dominated late medieval thought, and Galen, whose texts shaped Renaissance ideas about anatomy.

As Renaissance anatomists delved deeper into the human body, conflicts arose between their observations and the work of ancient authorities. This tension culminated with Andreas Vesalius (1514–1564), the great Belgian anatomist, whose careful investigations led him to challenge Galen. Ironically, Vesalius had worked on the preparation of Galenic texts while a medical student in Paris.

The illustration of scientific works greatly increased during the Renaissance, as well as the interest in copying nature. The herbals of Leonhard Fuchs and the hydraulic studies of Leonardo da Vinci boast the technical mastery in depicting three-dimensional perspective and bodily movement that proved Renaissance anatomical illustrations more realistic than those in medieval manuscripts. The rise of the printing press disseminated these new images, which were produced typically as woodcuts and integrated into anatomical texts as an important didactic component.

Although offering a more complex and naturalistic vision of human anatomy than existed previously, Renaissance illustrations nonetheless idealized the body, making it a metaphor for the greater cosmological order.

The Baroque: The Body as Machine

by Katherine Haskins

"For although it be a more new and difficult way to find out the nature of things by the things themselves than by the reading of books [or] to take our knowledge upon trust from the opinions of Philosophers; yet must it needs be confessed, that the former is much more open and less fraudulent, especially in the secrets relating to Natural Philosophy."
William Harvey
Anatomical Exercitations, 1673

Anatomical illustration of the seventeenth and early eighteenth centuries existed in an age of striking contradictions. The significant scientific advances of the time, symbolized by the works of the physicist, Isaac Newton (1643–1727), the mathematician and philosopher, René Descartes (1596–1750), and the physician, William Harvey (1578–1657), stood alongside devastating religious wars and persecutions. The tenets of a classical humanism inherited from the later Middle Ages and the Renaissance, were at once reinforced and called into question. The Baroque

William Cowper (1666–1709), British anatomist and surgeon

Myotomia Reformata, or an anatomical treatise on the muscles of the human body [2nd ed.?] (London: R. Knaplock, 1724).

Table 12: "[One of a set of écorché] figures...chiefly designed for the use of painters and statuaries. The outlines are copied from some of the greatest masters, and the muscles are laid in from life."

Etching, John Crerar Collection of Rare Books in the History of Science and Medicine, University of Chicago Library

The deluxe, posthumously published, 1724 edition of Cowper's important medical text, the *Myotomia Reformata*, includes a suite of etched plates. This depiction of an écorché (flayed) figure in full stride was meant to demonstrate the use of various muscles under motion and is one of a series in the book "chiefly designed for the use of painters and statuaries." The various renderings of musculature and skeletal structures aided artists in their figural representations, even as these images were drawn from life. A veristic depiction of the body in motion was greatly enhanced here by the use of the etching technique, which allowed for a vivid line and texture. This delicate, nervous touch signalled the rococo sensibilities of the early eighteenth century, even as it complemented a growing realism and precision in medical illustration.

age witnessed a growing tension between the search for coherent patterns in nature, the importance of devising systems of knowledge, and the strong desire to retain the pre-eminence and dignity of human endeavor as a sign of God's handiwork.

The human body was increasingly scrutinized and explained as a system or a relationship of parts to whole, and the prevailing visual metaphor was that of the "body as machine." William Harvey's crucial treatise on the circulation of blood, *On the Motion of the Heart and Blood in Animals* (1628), is a hallmark of contemporary interest in the mechanics of the body. The practice of Baroque anatomical and medical illustration was also part of a wider philosophical and aesthetic debate between the properties of surface and depth, the manifest and the "occult" (or the hidden), and the seen and the unseen.

Pictorial modes changed during the seventeenth and early eighteenth centuries: medical illustration began to move away from the allegorical, emblematic framework of the great frontispieces and narrative scenes and, instead, such illustration moved towards an ever greater monumentality. The mode of representation became highly refined and suggestive of greater aesthetic discernment and critical practice, even as the accuracy of such images increased. The emphasis shifted away from the display of aggregate images, often in densely cluttered compositions, and towards the display of discrete details or fragments, shown as single images or in spare groupings, and exhibited in ever greater detail.

The Age of Reason: The Body Dissolved

by Elizabeth Liebman

"It is very hard to think cogently about metaphysics or ethics without being an anatomist, a naturalist, a physiologist, and a physician."

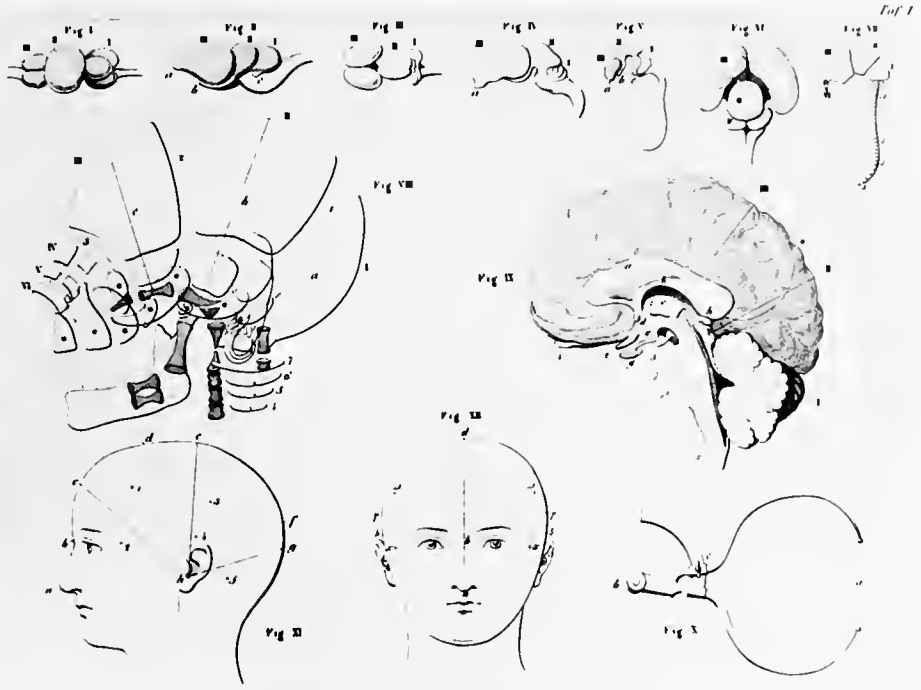
Denis Diderot
Eléments de physiologie, 1780

The eighteenth-century anatomist approached his subject with the rational optimism that characterized the early Enlightenment. The success of the exact sciences influenced all forms of systematic inquiry. Scientists explored natural phenomena according to Newtonian principles, or the measured observation of sensible effects--the laws of nature were to be discerned from evidence, not speculation.

Medical practice and education were not exempt: the New Philosophy and Method offered a remedy for the disorders of the body, the mind, and society. During the Enlightenment, self-knowledge and health were natural rights, indeed, they were thought capable of progress.

Rational, secular investigators sought a material explanation for human form, development, and physiology and thus inherent sensibility and irritability were attributed to deep body tissues and organs. For the French materialists, intelligence and passion sprang from organized matter. As Denis Diderot remarked, "The ideas, like the sensation, of all animals are nothing but the result of our organization."

In eighteenth-century anatomies, the idealized body of the Baroque era



Karl Gustav Carus (1789–1869), German physician

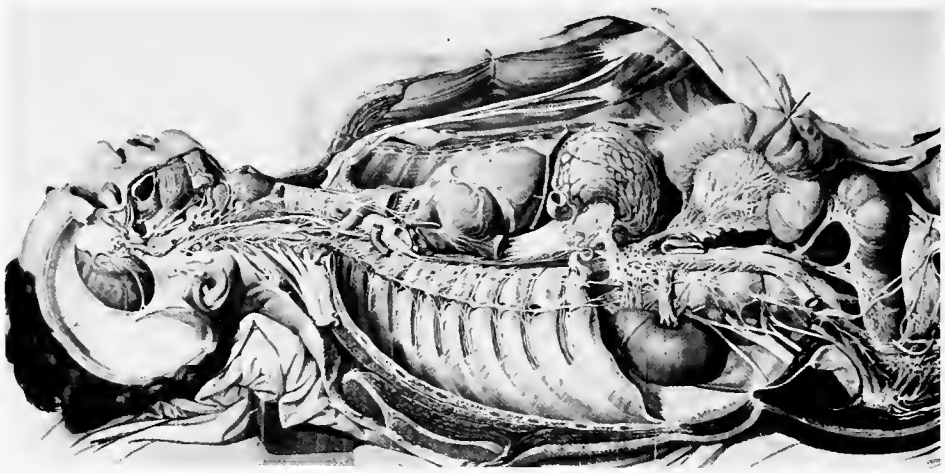
Grundzüge einer neuen und wissenschaftlich begründeten Cranioscopi [Characteristics of a New and Scientific Foundation of Cranioscopi] (Stuttgart: Verlag der Balz, 1841)

Plate 1: *"Vordere Hirnmasse"* [Frontal Hemisphere of the Brain]

Engraving, Purchase of the General Book Fund, University of Chicago Library

Phrenology epitomizes the fragmentation, quantification, and visualization characteristic of science in the nineteenth century. As a science, it attempted to reveal intangible mental qualities and abilities through the compartmentalization of the brain.

This illustration demonstrates the fragmentary and quantified approach used by phrenologists in their attempt to map character onto the head and brain. The schematized, universalized style of this illustration is typical of the early phrenological texts written for a scientific community. It reflects the theorists' concern with the precision and rigor associated with scientific disciplines. Later popular texts largely abandoned such scientific illustration in favor of emblematic representations of character and cranial comparison.



Jean-Baptiste-Marc Bourgery (1797–1849), French physician and anatomist

Anatomie descriptive de physiologique [Descriptive Anatomy of Physiology], vol. 3 of *Traité complet de l'anatomie de l'homme* [The Complete Treatise of Human Anatomy] (Paris: C. A. Delaunay, editor, 1844).

Plate 100: *"Resume general anatomico-physiologique du grand sympathique"* [General anatomical-physiological summary of the sympathetic nerves]

Colored lithograph by Nicolas Henri Jacob, delineator S. Ahlbom, printer Lemercier
John Crerar Collection of Rare Rooks in the History of Science and Medicine, University of Chicago Library

Bourgery's monumental *Traité,* published between 1832 and 1854, established the use of lithography for medical illustration. Its eight folio volumes consisted of 726 plates of limbs, organs, bones, circulatory, nervous and lymphatic systems, as well as surgical operations.

Bourgery intended his depictions of bodies to be "after nature" and their life size was thought to make them more useful to students and physicians for comparison with actual bodies.

The famous French comparative anatomist Georges Cuvier stated, in an 1832 report to the Académie des Sciences on Bourgery's work, that without illustration, natural history and anatomy would be impossible. Indeed, Bourgery's lithographs allow a degree of layering and detail unimaginable for earlier anatomists and a precision equated with scientific rigor in the nineteenth century.

dissolved into its constituent parts. Fragments, related only through mechanical function and developmental history, seemed to live up to La Mettrie's construction of "l'homme machine."

The display of body fragments in the anatomy texts paralleled the heterogeneous specimens exhibited in popular natural history "cabinets." Like these collections, assemblages of disparate organic parts constituted a natural history of the body. The eighteenth century also saw the rise of new graphic techniques and the improvement of older methods of reproduction. Etching, mezzotint, and color printing blurred the strict demarcation between inside and outside. Accordingly, the topography of the body became transparent, revealing an internal landscape.

The Nineteenth Century: The Triumph of the Fragment

by Tracy Teslow

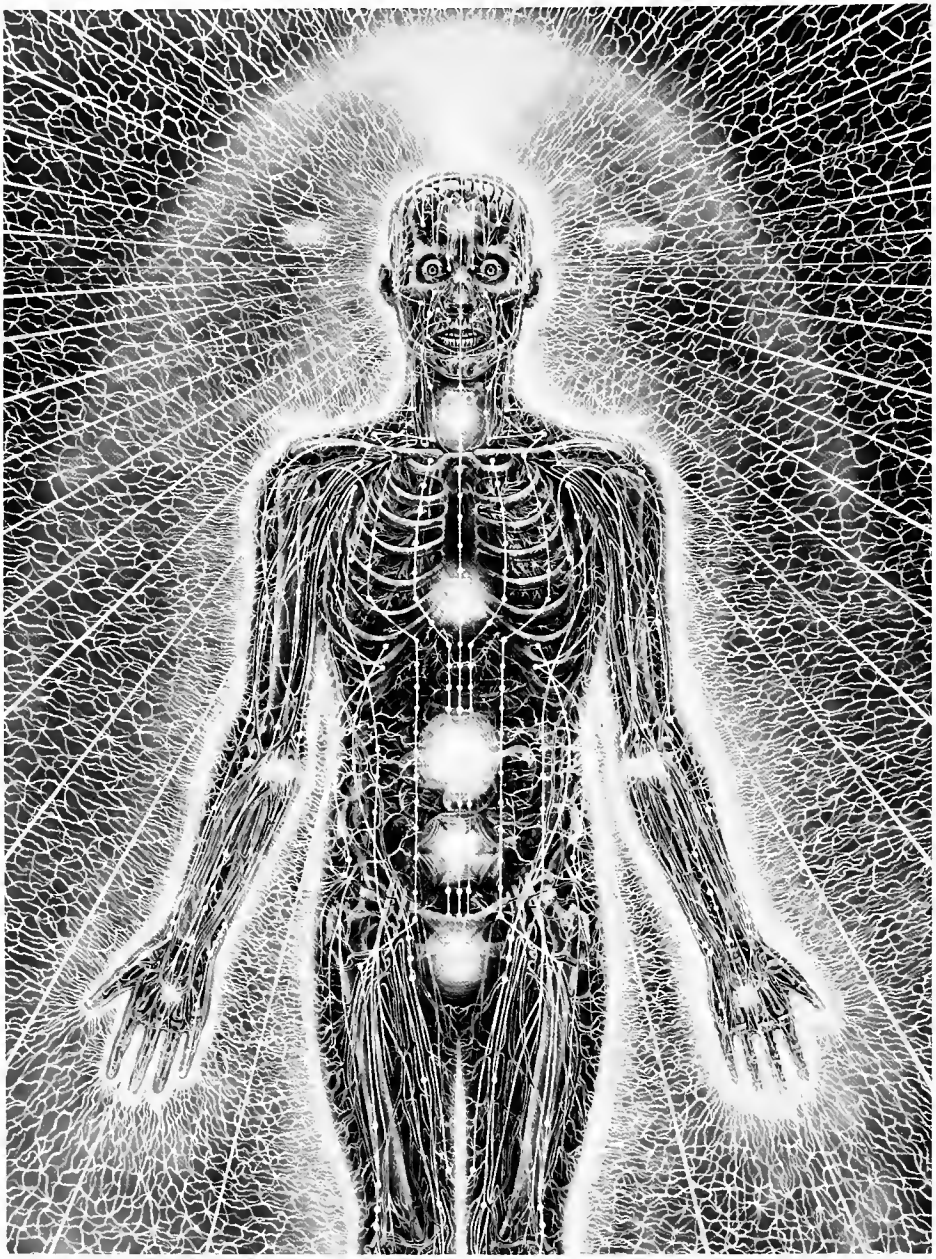
"Although anatomy is part of the natural sciences, it differs essentially from natural history. Indeed, natural history dwells upon forms, upon the exterior qualities of bodies, and is restricted, in whatever guise, to skimming their surfaces. Anatomy goes further: it penetrates bodies, divides them, isolates the parts of which they are composed, and seeks to lift the veil hiding the secret of their organization."

Francesco Antommarchi
Explication de planches anatomique du corps humaine, executees apres les dimensions naturelles, 1826

In the nineteenth century secrets of the body were revealed with ever-increasing precision and isolation. This corporeal dissociation can be witnessed in anatomical texts meant for students, practitioners, and laymen eager to see manifest what otherwise remains invisible. Lithography and color printing techniques enabled anatomists to achieve new levels of complexity and accuracy in their empirical quest to grasp and control the human body.

Increasingly, images of the body presented fragments. Bits of human flesh were objectified, quantified, codified, rationalized and thus existed apart from the whole to which they belonged. Apparatus and technology allowed anatomists and physicians to probe ever deeper. Anesthesia, microscopes, and antiseptics provided an endless number of opportunities for defining and managing bodies.

Realism and idealism coexisted in representation. The idealized, classical body (usually constructed with the "best" parts from several dissected bodies) pervades texts on normal anatomy. The reality of disease and deformity is found in pathological anatomies designed for surgeons and physicians. The idealized figure was taken to be the best representation of our divinely created selves. These often life-size images of perfection coexisted with dramatic presentations of tragic, dissected bodies. Such moralized anatomies continue to be produced but, by the nineteenth century, they had become mere fragments of individuals.



Detail from "Psychic Energy System"

The crux of the Sacred Mirrors *exhibition, "Psychic Energy System" presents an X-ray view of the physical body while interweaving the non-physical or psycho-spiritual energy systems.*

Acrylic on linen, 1980

Visions of Body and Soul

Inspiration for the Sacred Mirrors emerged after I had a series of mystical experiences that caused me to redefine my view of consciousness and the self. I saw the body as not just a solid isolated object in a world of separate forms and existential anxiety, but more like a manifestation of primordial energy of awareness that was everywhere present. . . . I wanted my paintings to visually chart the spectrum of consciousness from material perception to spiritual insight, and to function, if possible, as symbolic portals to the mystical dimension. . . . The obvious way was to present a believable and almost hyper-real portrayal of the physical body and then seduce the viewer into the stranger mystical dimensions.

Alex Grey, *Sacred Mirrors: The Visionary Art of Alex Grey*, 1990

Introduction

In my odyssey as an artist, certain themes have emerged over the years as my primary subject matter. The nature of consciousness and the cycle of birth, life, and death have preoccupied me as a performance artist, sculptor, and painter. While sifting through my childhood drawings, which my mother had kept in a large box, I was amazed to find among the very early pieces (drawn when I was four or five years old), a watercolor of a human skeleton. A later childhood encounter with the subject of human anatomy was undoubtedly my careful construction of the "Visible Man" model. I still recall the illustration on the black box it came in—a person with transparent skin, revealing all the internal organs, the skeletal and circulatory systems.

While an art student, seeking to know more about the relation of soma and psyche, I ventured into the Harvard Medical School in search of a human brain. I was admitted to the Warren Anatomical Museum, and there met a person who was to become my future employer and lifelong friend. David L. Gunner, an artist, was the curatorial associate in the Warren Museum and, like me, had attended the Museum School of Boston. David took an interest in my questions, showed me a human brain, and let me hold it. To hold in one's own hands what is perhaps nature's most complex structure, a key to the mysterious link between mind and body, was a deeply influential event. I realized that I needed to learn a great deal more about human anatomy if I was to reach any understanding of consciousness and

by Alex Grey

Installation of Sacred Mirrors at the New Museum, New York City, 1986

attempt to evoke it in my artwork. So, I began to frequent the Warren Museum and soon David found me a job.

I prepared exhibits on anatomy, pathology, and the history of medicine, all drawn from the Warren's extensive collection. Sometimes I cared for and restored specimens that would never be exhibited. Most of the specimens were examples of pathological anatomy—such as an arm with smallpox, or the skeleton of a person with rickets, or such truly phenomenal teratological specimens as Siamese twins or a sirenomelus (the fetal abnormality in which the lower limbs are fused, resulting in a mermaid-like appearance).

Originally, thousands of these so-called "wet and dry specimens" had formed the core of the Harvard teaching collection. In the late nineteenth century, three floors of Building A were devoted to the Museum, which served as the primary teaching area for medical students. As photography enabled a less bulky cataloging of human pathology, however, and as slide projectors replaced field trips to the Museum, the "teaching collection" assumed a less and less vital role in the preparation of succeeding generations of physicians. The Warren Museum was whittled down to a fraction of its original glory days, with massive purges of

Allyson Grey and Alex Grey casting the Sacred Mirrors frames, 1985

irreplaceable specimens. Yet, many of the most amazing pieces were retained and are presently on exhibit. I sometimes have imagined that this collection, assembled by such venerable ancestors of Harvard Medical as John Collins Warren, founder of the Museum and also founder of Massachusetts General Hospital, constituted something of the "soul" of the school. The wet and dry specimens provide a deeply human dimension to the study of medicine and pathology. To be able to pick up a bladderstone the size of a golf ball and see the tools used by doctors to cut for the stone prior to the use of anaesthesia and antisepsis cannot help but make one empathize with both the sufferer and the surgeon. A slide viewed for a few seconds, however, cannot convey the psychic resonance (and sometimes shudder of horror) of real pathological human remains.

Medical education and technology have vastly improved our understanding of the structure and physiology of the human body (especially in the cellular and microscopic regions), but we have also seen an increased psychological distance between physician and patient. It is rare, it seems, to find a physician who considers the patient as a whole person instead of as an isolated symptom or disease to be treated. These remarks are not intended to be cynical or offhanded. Alienation between physicians and patients is a very complex issue and not the focus of this essay. Given the condition of specialization that medical science is apparently bound to, it is within the domain of art to focus on the human being as a

whole, inclusive of body, mind, and spirit.

While working at the Warren Museum, attending lectures on anatomy, and doing dissection work on cadavers, I studied theories of Life Energy from Eastern as well as Western medical perspectives. I pursued many questions, including, What energy distinguishes the living from the dead? Life energy, the human soul, consciousness itself, are all intimate aspects of our experience of self, yet they are virtually unquantifiable and ineffable. While searching for a way to suggest these important human qualities in a visual way, I had mystical experiences that inspired me to paint the *Sacred Mirrors*.

The Sacred Mirrors

Sacred Mirrors is a series of twenty-one images, consisting of nineteen paintings and two mirrors, that examines in fine detail the human physical and metaphysical anatomy. Each image is forty-six inches by eighty-four inches, presenting a life-sized figure directly facing the viewer, arms to the side and palms forward. This format allows the viewer to stand before the painted figure and "mirror" the image, creating a sense of "seeing into" oneself. *Sacred Mirrors* may be used as a tool to visualize and focus healing energy to particular parts of the physical and metaphysical bodies.

Surrounding each image is an arched frame, measuring 60 inches by 126 inches, specifically designed for the *Sacred Mirrors*. The frames feature a brief history of the universe and provide a philosophical framework in which to view *Sacred Mirrors*. In the center, at the bottom of each frame, is a golden explosion of rays symbolizing both the Genesis of God's light and the "Big Bang." Moving up the left side are spinning galaxies, the solar system, and the earth, out of which spirals a double helix of DNA. Within the rungs of the DNA molecule is biological evolution—"the tree of life"—represented in seventeen steps, from blue-green algae to early man. At the bottom of the right side are comparative profiles and brain sizes of the ape, dawn man, and modern man. A double helix of serpents, representing mental evolution, spiral out of the right and left hemispheres of a human brain, each ouroborosly biting the tail of the future. The serpents, symbolic of the temptation of the tree of knowledge and of subconscious opposing forces that drive the evolution of consciousness, frame symbols of the progressive steps of technological evolution from the stone age to the space age.

Central to the arched top of the frame, an illuminated stained glass "Eye of God" serves as the radiant center of a Wheel of Life. On the horizontal spokes or radiances of the Wheel are balanced the opposites of birth (fetus) and death (skull); on the lower vertical radiance, the union of opposites is expressed as embracing lovers. On either side of the lovers are represented the stages of life from infancy to old age. Seated male and female elders hold the future of biological and technological evolution in their hands.

The apex of the frame contains an original symbol called the Polar Unity

Spiral. The symbol developed from a psychedelic vision in which I experienced a spiritual rebirth canal as a tunnel inside my head, continuously spiralling from darkness into light. Similar experiences of a journey through a dark tunnel toward the light are described in mystical literature, scientific papers on altered states of consciousness, and reports of near-death experiences.[1] Symbols of the paths of life—business, education, family, the arts, medicine—radiate from the lower hemicircle around the Eye of God. Wisdom paths indicated by symbols from some of the world's great religions radiate from the upper hemicircle.

The series of twenty-one paintings is divided into three equal sections generally described as body, mind, and spirit. The entire progression of the series from "Material World" to "Spiritual World" describes a process of transformation from body consciousness to spiritual consciousness.

Portrayal of the Material World

Sacred Mirrors begins with a piece entitled "Material World," which has more than one hundred actual mirrors sandblasted with symbols of all the known elements of the periodic table. A grid of lead strips welds the mirror/elements to a lead silhouette of a human figure. Deeply inscribed into the surface of the lead silhouette are the complex arrangements of elements that produce the biochemical constitution of the human body. When one sees oneself reflected in "Material World," the image is fractured, distorted, and completely obscured in the center of the mirror because of the opacity of the lead body.

Detail from "Skeletal System"

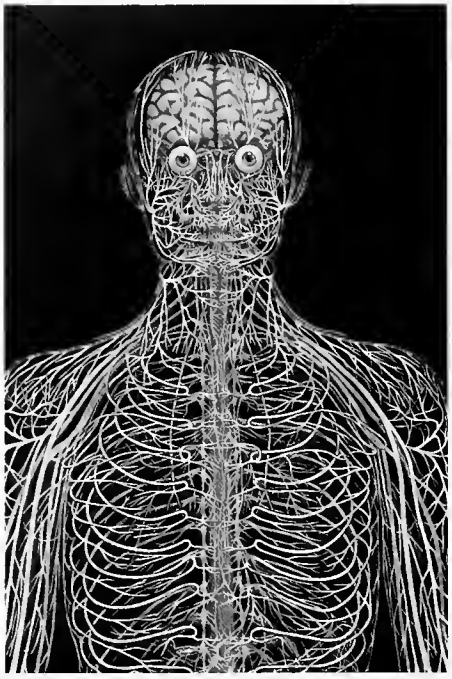
Oil on linen, 1979

"Skeletal System," the last of our physical remains, begins the examination of the gross anatomy. The skeleton is also the archetypal symbol of death. The initiatory ordeal of shamans (of various cultures) requires contemplating one's own skeleton and naming the bones in a sacred tongue to induce the mystical experience of death and resurrection. Made up of more than two hundred bones, the human skeleton provides the inner scaffolding and determines the primary outer design of the body, and as such is an architectural and engineering masterpiece.

"Nervous System" presents the integrating master of all other systems in the

body and the ultimate anatomical vehicle of consciousness. The nervous system gathers all sense impressions, coordinates all actions, and is the channel for all feeling and thinking. The seed and source of this system, the human brain, is made up of trillions of intricately interwoven cells, and is the most complex and mysterious object known to humanity.

The mountain of knowledge about the nervous system grows each day, yet how the complex interaction of individual cells leads to our experience of consciousness—as well as a centralized concept of self with focused awareness—will never be understood from a strictly anatomical perspective. The brain understanding the brain is like a dog chasing its own neuronal tail; helpful knowledge and theories will develop, but the mystery of the mind remains.



Detail from "Nervous System"

Oil on linen, 1979

"Cardiovascular System" depicts the heart, that fountain of life blood, surrounded by a network of the most intricate plumbing. "Lymphatic System" presents a network of vessels, nodes, and lymph-producing organs crucial to the immune response. The immune system determines that which is "not self" and then fights it off. The new science of psychoneuroimmunology studies the interaction of such psychological factors as stress with the immune system, and a convincing body of evidence links various personality factors with health and disease.

"Viscera" shows a man flayed open, exposing heart, lungs, stomach, liver, intestines, and the brain. The digestive system is one long tube that carries food through the processes that break it into energy and waste. The lungs supply our bodies with essential oxygen and remove carbon dioxide. The liver is the great storehouse and processor of food, breaking it down into useful amino acid chains. The liver also protects the body by collecting ingested toxic substances, chemically treating them, and rendering them harmless.

In "Muscle System," we see a woman, strong and pregnant, with a window cut away to reveal her delicate eight-month-old fetus. The muscles of the abdomen go through an incredible expansion during pregnancy—an archetypal example of the transformative potential of the body. The muscles weave around the skeleton and provide

the opposing forces needed for body movement. Connected to the bone by tendons passing across the joints, the muscle fibers contract or pull together to perform motor movements. Many different shapes and sizes of muscles harness the body. Extremely tiny muscles perform functions like contracting the arteries or contracting the bronchial tubes of the lungs. The muscles determine the superficial appearance of most of the surface of the body.

Each painting in this section of *Sacred Mirrors* is based on anatomical atlases and actual dissections, and depicts the anatomical systems with careful accuracy. Though thoroughly dissected, the figures stand and stare with moist eyes as if healthy and alive. They reflect our own mortality. The inner systems reflect a profound, shared human experience and a miracle of nature that we rarely appreciate, unless the systems are disturbed or unveiled. The approximately sixty trillion cells in the adult body are dying and being replaced at the rate of five million per second, and yet this unfathomably complex whole system, the body, is only our physical vehicle.

By 1980, I had painted many of the physical systems for *Sacred Mirrors*—including the "Skeletal System," "Nervous System," "Cardiovascular System," and "Viscera." Yet if *Sacred Mirrors* was to convincingly portray life energy and spiritual dimensions of consciousness, I would also have to include a rigorous analysis of the human anatomy because the body is the carrier of these forces.

Detail from "Viscera"

Oil on linen, 1979

Medical Illustrating

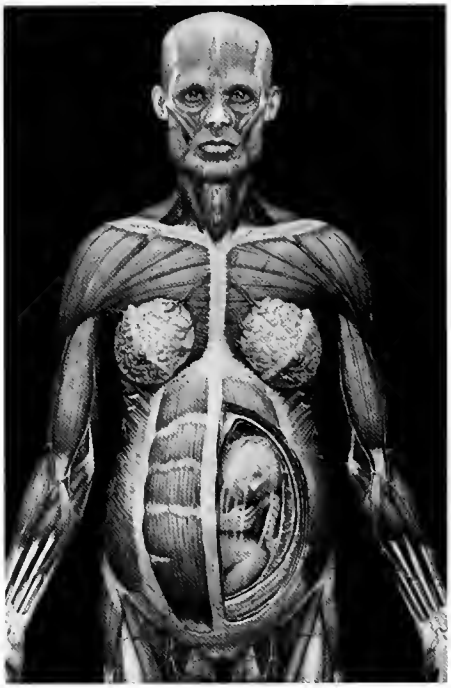
Painting the *Sacred Mirrors* resulted in some unusual opportunities. There were doctors who had seen my physical anatomy paintings, and one of them recommended me for producing medical illustrations needed by a diagnostic lab. I have never been able to determine who volunteered my name, but that person changed my life. I soon found out that medical illustrators earn a great deal more money than I was getting at the museum, so I left my job there. For the past twelve years I have worked steadily in the field of medical illustration to support my family, thanks

to *Sacred Mirrors* and an unknown friend.

There are many challenging aspects to working as a medical illustrator. There is always much new technical information to absorb and visualize. But being a medical illustrator is not my primary purpose in life. My wife, Allyson, and I work together. She does solicitation for work and keeps the records straight, and I do the illustrations. We do the business to support our art careers. Primarily, we think of ourselves as artists, we are both painters. But unfortunately, painting sales are notoriously undependable. Some years art sales go well, other years not. This is the situation with many artists.

In 1986, all twenty-one framed *Sacred Mirrors* were exhibited at the New Museum in New York City. Many people saw the show; in fact, it became one of the most popular exhibitions. As a result, numerous invitations were offered, including a traveling show across Canada. One of the most amazing opportunities came from Jean Watson, then dean of the School of Nursing and founder of the Center for Human Caring at the University of Colorado. Dr. Watson believed that my work illustrated her epistemology of healing and human caring—an idea that excited me—and she worked with the Department of Fine Arts to bring *Sacred Mirrors* to the University of Colorado galleries. I was a participant in an accompanying symposium on nursing and human caring, also organized by Dr. Watson.

My work was obviously not part of the mainstream of the art world, however. Some critics and collectors seem to



Detail from "Muscle System"

Oil on linen, 1980

be confounded by it, but people in many walks of life have an instant affinity. Therefore, I have found an alternate or adjunct to the "legitimate" (and extremely fickle) New York Art World, by making my work popularly available through a large format fine art book, entitled *Sacred Mirrors* (now in a third printing in two years), posters, greeting cards, and a calendars.

Portrayal of Mind and Spirit

The first seven paintings I have described portray the body, whereas the second section of *Sacred Mirrors* roughly corresponds to our function of mind, and can be said to focus on the mind's most superficial level of perception—sociopolitical perceptions

conditioned by our prejudices and sympathies concerning appearances. The skin, the largest organ of the physical anatomy, denotes our individuality. Whereas many of the inner systems exist similarly in all people regardless of race or sex, skin makes our differences obvious. *Sacred Mirrors* shows a man and a woman of each of the three races: Caucasian, African, and Asian. The viewer is presented with the challenge of seeing oneself reflected in others, as a member of another race or sex, and feeling prejudices and sympathies as they arise.

"Psychic Energy System" is the crux of *Sacred Mirrors* because it presents an X-ray view of the physical body and interweaves the non-physical or psycho-spiritual energy systems. It also introduces the next phase of *Sacred Mirrors*, a complex variety of nonphysical or esoteric energy systems and spiritual archetypes that could be called the metaphysical anatomy of the human being.

"Psychic Energy System" was created from descriptions by clairvoyants and aura readers of the colors and shapes of the astral and etheric auras surrounding the body, the seven central chakras, and the golden white light of the acupuncture meridians and points.

According to Hindu yogic tradition and psychic analysis, there are seven primary chakras (or wheels) of metaphysical energy located along the central axis of the body. The chakras mediate the energies of the egg-shaped astral and other higher "bodies" with the etheric energy layer closely surrounding and interpenetrating the physical body. The chakras present a model hierarchy of the evolution of consciousness or its development.

The lowest chakra, situated in the genital region, is the source of the primal hungers and drives. The second chakra, corresponding to the emotions and "gut reactions," is the primary connection point between the emotional or astral body and the physical. The third chakra corresponds to reason and intellect, and connects the physical to the mental body. The development of the next four chakras depends on awakening an awareness of the higher self, beyond the ego, and takes one more consciously toward self-knowledge and self-realization. The heart chakra is the channel of love and provides the first opportunity we have to become transrational. Positive development of the throat chakra channels divine will and higher authority and represents the capacity to lead. The third eye not only opens one to creative spiritual vision but also serves as the tunnel to the highest chakra. The opening of the highest chakra is the goal of yoga, the experience of the union of God and Self.

The color of blue purple was chosen as the predominant color for the "Psychic Energy System" because, according to renowned clairvoyant C. W. Leadbeater and other psychics, blue purple represents high spirituality. The entire body is immersed in and interpenetrated by an oceanic lattice of energy that represents the prana (or vital ether), one of the pervasive life-supplying energies recognized in both Eastern and Western occult spiritual traditions. Although these subtle systems have formerly

been unverifiable by scientific means, in recent years scientists in Japan, the United States, and the former U.S.S.R. have teamed up with psychics and devised instruments and experiments capable of monitoring some of these energies.[2]

The Hebrew symbols located on "Psychic Energy System" represent the cosmological tree of life in Kabalah, Jewish mysticism. The Kabalistic tree, when keyed to the human body, is known as the Adam Kadmon or First Man, and denotes the emanation of the highest spiritual world from above the head down through the physical world at the feet. The symbols represent ten divine attributes, including wisdom, mercy, judgment, and beauty. Inside the seven chakras, which present a similar spiritual-to-physical spectrum, are the Sanskrit symbols indicating the sounds and meanings of each energy center, according to Hindu tradition. For example, the highest center, located above the crown of the head, the "thousand-petaled lotus," contains the mantric symbol Om, the primordial mantric resonance of the infinite and eternal.

The "Spiritual Energy System" is an image of heightened awareness. The body has become a permeable channel for the circulation of the subtle and fine energies of spiritual consciousness that are ever-present and interpenetrate the self and surroundings. Parallel lines of force stream through the body, extending out of the crown of the head and curling back around to the feet, creating a toroidal flow.

"Universal Mind Lattice" portrays an advanced level of spiritual reality that transcends the physical body and all material objects. The Self is seen as a torus-like energy cell, a fountain of consciousness within an infinite, omni-directional network of similar cells. The Self is distinct from every other cell, and at the same time, in complete union with all energy centers in the network. The surrounding cells represent the energy source of every other being and thing. The energy of the "Universal Mind Lattice" is love. The unified network of energy bodies represented in the painting could be called the Body of God, the Atman in the Brahman, or the fabric of being, beyond space and time.

Sacred Mirrors opens with the opportunity to see oneself in the fractured mirror of the "Material World," and closes with another mirror reflecting the unbroken "Spiritual World." It is essentially the same world, but transformed—a world of unity and interrelatedness. In the center of "Spiritual World" is a radiant sun, located approximately where the heart of the viewer might be. According to two of the oldest Upanishads of Hindu mysticism, the Brihadaranyaka and Chandogya, composed between the ninth and the sixth century B.C., "the heart" is the region where the incarnating transcendental self resides. The illuminated heart sun radiates a network of light throughout the space in the mirror, and carved into its center is the name of the source of the light and the self. The final mirror is an invitation to reflect not only on oneself and others but also on one's entire surroundings as an aspect of God.

Sacred Mirrors presents a multidimensional search for the Self. The Self is

recognized as that which underlies, unites, and directs the many physical and metaphysical systems. The purpose of *Sacred Mirrors* is to reflect on and appreciate the sacredness of the individual self, one's unity with other people and cultures, and one's connectedness with the earth and universe. *Sacred Mirrors* shows that the material and spiritual worlds are only reflections of the inner sacred mirror of the Self, which can be nowhere depicted, only realized.

Reflections

Through creating *Sacred Mirrors*, I learned to map the simultaneously occurring multiple dimensions of body, mind, and spirit by dissecting the dimensions of an individual. After painting *Sacred Mirrors*, my challenge was to carry this multidimensional perspective into such archetypal human experiences as praying, meditation, dying, kissing, copulating, pregnancy, birth, and nursing.

After the book about *Sacred Mirrors* and my other artwork was published in 1990, I began hearing from people who had experiences similar to ones I portrayed in the book. I received comments from clairvoyant healers who claim to be able to see the human body as though it were translucent, surrounded and interpenetrated by auras and energy channels, looking much like my X-ray painting. Many tantric texts explain that clairvoyance will develop as a byproduct of spiritual practices. I believe that the ability to see these various layers of reality is a talent that some people are born with and that some people have developed, but it is also a talent that is potential in all people. Occasionally in dreams, meditation, or psychedelic sojourns I have had glimpses and visions of these subtle hidden dimensions. ,

Although two-dimensional paintings are in some ways poor carriers of the information of the multidimensional mystical experience, they can provide enough information that people who have had similar experiences feel a deep resonance or strong degree of identification with the image or the work of art. This is an amazing thing that art has the capacity to achieve. In the spiritual art experience, there is a breakdown of the defensive barrier between self and other. One's identity becomes fused with the object, which opens a portal to the dimension that produced the object. With spiritual art, the ego is dissolved and one has an experience or a memory of a mystical state beyond the subject object duality. This is the power that sacred art can have. It uplifts one's awareness and taps into a higher dimension. In a sense, artwork can be a way to safely experience altered states of consciousness.

My paintings require a great deal of patience to work out the details; sometimes months of labor go into particular works. I have worked as much as a year on a single piece. This labor intensiveness is a devotional activity. There is an energy that one puts into any work of art; using one's hand on the object, pouring one's feelings into it, thinking about the object, actualizing the vision that one has had. A great range of energies of consciousness go into the work. I think of artwork as a battery of

JOURNEY OF THE WOUNDED HEALER

The first panel depicts the self in a dizzying vortex of evolutionary descent. This fall parallels the hallucinatory descent of the initiate shaman into the dark underworld where, in the middle panel, he is dismembered. The contracted physically-based ego is destroyed, and the last panel shows the radiant and reassembled healer ascending a crystal mountain.

Triptych, oil on linen, 1984-1985

consciousness that the artist charges or energizes as he or she creates. The receptive viewer is zapped by this battery of informational energy. To the degree that the viewer is receptive, that is the degree to which the intensity of the aesthetic experience or the full delivery of energy can take place.

As a contemporary artist, my problem has been to create authentic sacred art outside of a specific religious tradition. It has been said that science has nearly become a religion in the twentieth century, because many people believe in nothing else. Whether this is true or not, the discoveries of science have transformed the world we live in. As we look back over the past century we cannot fail to be moved by triumphant outer space missions with photos of our beautiful home planet and horrified by the cruel efficiency and mass destruction wrought by military and industrial technology. This is a critical time for the human race when intentionality is extremely important in every field of endeavor. As an artist I have felt that it is important for my intentions to be positive, healing, and spiritually enriching. I have also intended that my work be truthful in the deepest sense. The precise portrayal of the physical anatomy has been one of the ways I have tried to integrate a basic accuracy into mystical and visionary dimensions of consciousness.

All our actions, including art, occur in an ethical web of interrelatedness. The type of energy we put out in the world has potential for bringing harm or benefit. So, our intentions are crucial. Although contemporary art should not deny the dark aspects of life, suffering, and impermanence, it must also seek to create life-affirming statements—encouragement for people to choose life and the illuminating unifying light of the Spirit. Seeing our connectedness can help people cut through the confusions and divisiveness of the rational mind. The common ground of the spirit and the planet—our transcendent and immanent unity with all beings and things is our real home, our real nature, our real family.

■

Notes

1. Walter N. Pahnke and William A. Richards, "Implications of LSD and Experimental Mysticism," *Journal of Religion and Health* 5 (1966): 175–208.

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For more information about* Sacred Mirrors, *write the author at 725 Union Street, Brooklyn, NY 11215

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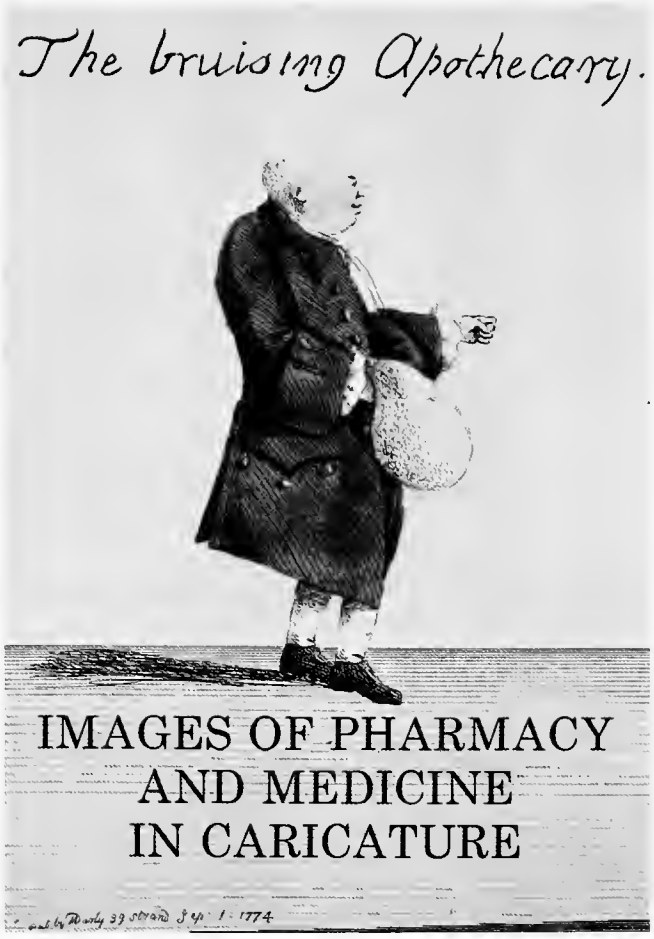
Book Review

The Bruising Apothecary: Images of Pharmacy and Medicine in Caricature

By Kate Arnold-Forster and Nigel Tallis. London: Pharmaceutical Press, 1989. Softbound. 92pp. Illus. £9.50.



The Bruising Apothecary is the catalog of prints and drawings in the Collection of the Museum of the Royal Pharmaceutical Society of Great Britain. Responsibility for formation of the collection of images of pharmacy and medicine in caricature began with the Society's Librarian, Agnes Lothian Short. Shortly after World War II, Short recognized that despite a very modest budget historically significant materials were obtainable. The Society's magnificent collection is the result.

As Kate Arnold-Forster and Nigel Tallis explain in their informative introduction, caricature was transformed in eighteenth-century England from "an exclusive dilettante amusement into a powerful form of social and political critique" (page 5).

by Glen W. Davidson

At first, English caricatures were viewed within a tight circle of an affluent and literate audience. By the end of the eighteenth century, however, there was a proliferation of prints by amateurs, and the social and political scope of satire took on a broadened significance.

Against historians' common focus on the rise of the professions of pharmacy and medicine in that era, the caricatures remind us that members of the established medical order were not the only practitioners of the period. In fact, the authors argue, many of the prints "emphasized the lack of distinction between the recognized physician, surgeon or apothecary and the irregular or quack" (page 8).

The Bruising Apothecary is the first catalog of its kind to be produced by the Museum of the Royal Pharmaceutical Society of Great Britain. The 171 items in the catalog are arranged in the following categories: Portraits of occupations and individuals, Diseases and their treatment, Advertisements and proprietaries, Concepts and emotions, Political and social subjects, Anthropomorphisms, and the Royal Pharmaceutical Society of Great Britain. Besides the introduction, the catalog includes biographical notes, a select bibliography, and an index of artists, engravers, and publishers.

The Bruising Apothecary should be of interest to both specialist and nonspecialist readers, as well as a valuable tool for librarians, museum curators, and collectors.

The book is available for $24.95 from Rittenhouse Book Distributor, Inc., at 511 Feheley Drive, King of Prussia, PA 19406.

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